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[OFFICIAL NOTICE.]

Instituting "Wrinkle" and "Novelty Advertising" Departments, Ohio Gas Light Association.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF THE SECRETARY,
DELAWARE, O., Dec. 7, 1900.

For the seventeenth annual meeting of the Ohio Gas Light Association, which is to be held in Dayton, O., March 20th and 21st, 1901, the Executive Committee has created two new features, viz.: A Wrinkle department, for which Mr. Henry L. Doherty, President Denver Gas and Electric Company, Denver, Col., has been named as Editor; and a Novelty Advertising department, which will have for its Manager, Mr. B. W. Perkins, Superintendent South Bend Fuel and Gas Company, South Bend, Ind.

These departments should prove very attractive for the meeting. Their success, however, depends largely upon the active co-operation of the members. It is, therefore, earnestly hoped that the fraternity will not be backward in sending Wrinkles to Mr. Doherty and "Advertising Schemes" to Mr. Perkins. T. C. JONES, Secretary.

BRIEFLY TOLD.

ANOTHER FLAW THAT PROMISES FURTHER CRACKING IN THE DIETERICH SYNDICATE.—About the most ridiculous thing that has been published broadcast of recent years in this country, respecting and affecting the gas industry, is the pronouncement, made public in the general press of last Thursday by Mr. F. S. Hastings, who is said to be the real President of the Indianapolis (Ind.) Gas Company, although many of those long engaged practically in the gas trade have thought that he was Mr. E. C. Benedict's financial "clerk." Mr. Benedict is the gentleman who, with the assistance of Mr. C. F. Dieterich, of Baltimore and elsewhere, "reconverted" the gas situation in the Mound City and other places, by putting such places on a stock basis from which no gas engineer could ever cause dividends to return and meantime allow to the consumer a chance for cheaper gas. However, the syndicate, having quit Baltimore, under the firm belief that there would never be a chance on earth for the stock that was printed by them, to earn a dividend, the syndicate selected Indianapolis, Ind., which was blessed by being in near touch with a wonderful natural gas field, as another favorable working ground. The syndicate, it must be admitted, did pretty well with that venture, for dividends good and high on a right heavy capitalization, were continued up to now, but the financiers would not hearken to the words of their engineers. Time and again the former were told, and the telling was uttered years ago by the latter, that the sources of supply were diminishing and that the pressure was decreasing, but the Dieterich-Benedict combination, knowing little about natural laws, and less about engineering practice (although Dieterich was presumed to have quite a bit of knowledge regarding the latter), declined to listen to the urgings of men like James Somerville and his associates, in their pleadings for money for allotments on storage and distribution account. The goose was mother earth; she was yielding the gas, and the ganders in control were to work the goose forever. But the goose sickened, and the ganders commenced to loose their rich looking feathers. Not to carry this way of illustrating the case any further, it is enough to say that the iniquity of the Dieterich syndicate, in wasting the natural gas supply under their control in Indiana, through lack of respecting the recommendations of trained engineers paid by it, cannot be concealed in the yawp let forth by "President" Hastings in the daily press of Thursday, who, in excusing the syndicate's decree not to pay for the present dividends on the stock of the Indianapolis Gas Company, tries to make the consumer, if not a waster of gas at *least* a gas thief. The Hasting's circular—and it is a pity that it ever was written—is as follows:

"It is with regret that your Directors are forced to make known to you the reasons which have compelled them to defer action for the present on the question of dividends. Under an old municipal ordinance your Company has been selling natural gas in Indianapolis by contract without meter measurement. Originally this plan was accepted generally by natural gas companies in the belief that there was an unlimited supply of this valuable product. The resultant wastage of gas, as is now well known, has brought about a greatly diminished pressure in the field, which has made it impossible to render satisfactory

service. Every effort has been made to secure municipal legislation requiring the adoption of economical devices and the compulsory use of meters for measuring the gas; but owing to the opposition of the people of Indianapolis our efforts in that direction have so far failed. In the meantime, other cities and towns, realizing the importance of conserving this most valuable fuel, have adopted the system of selling gas by meter, with satisfactory results not only to the local companies but to the consumers themselves.

"It is well known that the adoption of meters would not materially increase the receipts of the Company, but would accomplish two more important objects, viz: The prolongation of the supply in the field and the insurance of a more satisfactory and economical service to the consumer. Notwithstanding the fact that we have expended large sums of money in new wells, pump stations and additional pipe lines in the field, for the purpose of bringing a greater volume of gas to the city, it has been found impossible to furnish a satisfactory service, so long as the present wasteful use of gas is continued; at the same time our revenues have very largely decreased in consequence of the wide extent of this practice.

"In spite of existing prohibitory statutes a large percentage of our customers have unlawfully increased their supply by the practice known locally as 'boring out' their mixers. Every effort has been made by your managers to stop this unlawful wastage, but although the best legal talent has been employed, supported by indisputable proofs, it has been found utterly impossible to secure a conviction because of the fact that this illegal practice has been so generally indulged in. These violations of the law are not confined to the poor or vicious, but include city and county buildings, city officials, lawyers, churches, ministers of the gospel, physicians, architects and some of the most prominent residents and business houses in the city of Indianapolis. Thus our efforts to secure to the law abiding citizen a good service have been frustrated by the illegal action of other consumers, and it is obvious that further effort in such a direction is hopeless, both from an engineering and financial point of view.

"Notwithstanding the alarming condition, which we have recited above and which your Directors have so far been powerless to prevent, it is our confident belief that the people of Indianapolis will surely awake to a realization of the necessity, in their own interests, of securing such legislation as will extend the duration of the supply of this most valuable fuel to the utmost possible limit. Meanwhile, your Directors are determined to use every honorable effort in this direction and to apply the revenues of the Company to the protection of its property."

OBITUARY NOTE.—MR. CHRISTOPHER CUNNINGHAM.—We regret to have to report the death of Mr. Christopher Cunningham, senior member of the firm of Christopher Cunningham & Son, proprietors of the Novelty Steam Boiler Works, of Brooklyn, N. Y., whose death occurred at his home in Brooklyn, the morning of the 9th inst. Deceased was in every sense a practical worker in plate iron, and the fact of his death, even though that did not come until age had well ripened his faculties, will bring honest regret to all his contemporaries in trade who knew him; and they are many. Mr. Cunningham was born in Westmeath County, Ireland, December 25th, 1826. Settling in New York City in 1848, where he thoroughly acquired the knowledge and practice of boiler making, he removed to Brooklyn in 1858, establishing there a plant, under the title of the Novelty Steam Boiler Works, in the eastern section of the Seventh ward. In 1872 he constructed a capacious plant on Newtown Creek at Greenpoint avenue, Brooklyn, and operated the same alone until 1895, when his son, Christopher Cunningham, Jr., was admitted to partnership in its management and ownership. His personality was a singularly pleasing one. He is survived by a son and three daughters.

NOTES.—Mr. E. J. Elles, formerly Manager of the Macon (Ga.) Gas Light and Water Company, resigned that post to accept the position of Manager of the Evansville (Ind.) Gas and Electric Light Company. ——The franchise for the construction and operation of a gas plant at Lehighton, Pa., has been secured by Mr. W. E. Ash, of Lehighton, and Mr. W. H. Fritchman, of New York. Under the agreement the grantees may charge not to exceed $1.50 per 1,000 cubic feet net for an 18 candle power gas, must commence construction by May, 1901, and complete the work in 12 months thereafter.——On January 1st, 1901, the net charge for gas supplied by the Minneapolis (Minn.) Gas Light Company is to rule at $1.20 per 1,000—a concession of 10 cents per 1,000.——The Consolidated Schuylkill Gas Company, of Phœnixville, Pa., is adding to the capacity of its generating plant. The United Gas Improvement Company is erecting the addition, which is to consist of one of the latter's standard double superheater, Lowe water gas settings, with a daily capacity of 250,000 cubic feet.

[*Journal of Gas Lighting.*]

Professor Lunge on Coal Tar and Ammonia.[1]—No. I.

Thirteen years have passed away since we had the pleasure of reviewing the second edition of Professor Lunge's standard treatise on "Coal Tar and Ammonia." In the meantime, much has happened in connection with the coal tar and ammonia industries to make a thorough revision of the 1887 edition imperatively necessary, to keep the work abreast of contemporary changes. We refer not so much to technical improvements in the methods of utilizing tar and ammoniacal liquor for the production of commercial substances, as to the great changes in the quantities and sources of the raw materials and the relative market values of the different products obtained from them. It has not been Professor Lunge's practice to ignore the importance of these factors in determining the utility of an industrial text book, and consequently there was much in his 1887 edition which needed amendment to bring the information up to date. Readers of German, indeed, were able to obtain a later edition of the book; and the third English edition which is now before us contains all the new information given in the latest German edition, in the preparation of which Professor Lunge was assisted by Dr. H. Köhler.

In 1887, we gave a full account of the scope and contents of the second English edition (see *Journal*, Vol. L., pp. 491, 534 and 575); and we cannot now do better than indicate the extent of the changes which have been made in the present enlarged edition. The work broadly may be considered as comprising an introductory chapter, and two distinct and independent parts, one dealing with "Coal and Tar and its Products," and the other with "Ammonia." The introductory chapter, which gives general particulars on destructive distillation and the quantities of coal raised and carbonized, has now grown from 15 pages in the second edition to 20 pages in the present one. Unfortunately, all matter has been retained from the old edition, and additions merely made where it was obviously out of date. But why are not the figures and facts of 1884 and 1885 simply discarded in favor of those of (say) 1898? One would suppose, from quotations from "Field's Analysis" giving the amounts of coal carbonized by leading English gas works in 1884 and 1885, that later data from the same or other reliable sources were not available. To argue, on the basis of these out-of-date figures, that because Manchester and Liverpool then carbonized more cannel than common coal, and London only 2 per cent. of cannel, London tar is, and should be, much lighter than country tar, is palpably ridiculous now, in the light of the reduction which has been made in the amount of cannel carbonized since 1885. Matter such as this should have been excised in the revision of the work. A reader does not want facts and figures of a past age given with even greater emphasis and detail than those relating to the present day. In this introductory chapter, much remains that was valuable in 1887, but is now comparatively speaking useless; while later information is appended in a disjointed manner, and obtained apparently from less well accredited sources. If Professor Lunge did not think it worth while to give particulars of the amount of coal carbonized by the leading English gas works during the last few years, it was certainly not worth while to repeat those for 1884 and 1885. He evidently has not had the inclination to revise his work in a manner which would make the third edition as good now as the second edition was at the time of its issue in 1887.

The part of the volume which deals solely with tar and tar products has grown from 499 pages in the second to 643 pages in the present edition; and the illustrations now number 201, against 138 formerly.

The first chapter of this part deals with "Processes for Obtaining Coal Tar;" and the production at gas works is considered at the start. There is little alteration here since the earlier edition. With reference to the Pelouze and Audouin extractor, we were under the impression that its use had spread of late years on the Continent, and are consequently somewhat surprised to see the following comments retained verbatim from the 1887 edition: "This apparatus is employed at many French gas works, and it has also been introduced to a certain extent into other countries, for instance, into Germany; but it has not made its way there." We wonder if the author really thought this statement equally satisfactory now, in the light of the fact that the Pelouze and Audouin apparatus has since 1887 been introduced in many Continental gas works, and notably in the new central gas works at Vienna. Passing on to the recovery of benzol from coal gas, or rather coke oven gas, we find that a good deal of information has

1. "Coal Tar and Ammonia." Third and Enlarged Edition. By George Lunge, Ph.D., Professor of Technical Chemistry in the Federal Polytechnicum, Zurich. London: Gurney and Jackson, 1900.

been added in the new edition. The recovery of benzol from coke oven gases commenced in Germany about 1890; and by 1895 the annual production there was from 4,500 to 5,000 tons. In an addendum, it is stated that the German coke ovens in 1899 produced 32,000 tons, and that 22,500 tons were consumed in German color works, and 2,500 tons in carburetting coal gas. It is computed that if all coke ovens were fitted with the condensing plant, the amount recovered would be upwards of 80,000 tons per annum. These figures are an interesting adjunct to the particulars given by Dr. Bunte and others in connection with the benzolizing of water gas, as reported in our columns to-day (p. 1332). The cost of benzol recovery, however, is not slight, for on Donath's authority it is stated that plant for dealing with the gas from 300 tons of coal per diem costs £4,300; and the expense of working, inclusive of interest and amortization, amounts to about £4,350 per annum. The yield of benzol is said to vary from 0 3 to 1.1 per cent. of the coal carbonized. The next branch of the sub ject dealt with is the older one of the recovery of tar from coke ovens; and on this the bulk of the information given in the former edition remains unaltered. Some additional particulars are furnished of the adaptation of beehive ovens for the recovery of tar. Some later improvements of the Otto ovens are also now described. We are glad to see that a good deal of descriptive matter relating to the original Carvès ovens is omitted from the present volume, and that some information on the working of Semet Solvay ovens is introduced. Apparently no progress has been made since 1887 in the recovery of tar from gas producers; but there is more said about tar from blast furnace gases, which now affords useful products, though it is different in character from gas works tar. Then we find a new section on tar obtained in the manufacture of water gas. The information given is singularly disjointed and unsatisfactory; and it is evident that the author is without any practical acquaintance with this tar, and did not consult the best recent authorities on it. Anyone who may be tempted to refer to this work for particulars about the qualities and uses of water gas tar will be grievously disappointed at the scanty treatment it receives. There are a number of new facts about the production of benzene from petroleum residues; and the chapter closes as before with an account of a method for testing coals for their yield of tar.

The next chapter on "The Properties of Coal Tar and Its Constituents" has been considerably enlarged by the fuller description of previously unimportant bodies, and by the introduction of some theoretical speculations on the formation of the constituents of coal tar. On the whole this chapter forms a useful and reliable collection of the more valuable facts concerning the carbon compounds which are found in coal tar. It is one of the best in the book; and we cannot well give it higher praise than this.

The next chapter on "The Applications of Coal Tar without Distillation," is one of the most interesting to gas works managers. It has been enlarged since the last edition of the work, and now contains, *inter alia*, a fairly good summary of the points for and against the Dinsmore process for obtaining gas from tar. The favorable views of Messrs. Isaac Carr and Watson Smith are quoted, and Kraemer's unfavorable results, which are supported by experiments made by Dr. Bueb, for the German Continental Gas Company. It is perhaps worth while, in view of the continual revival of attempts to make gas from tar, to reproduce a few sentences dealing with Kraemer's trials of the Dinsmore system. Thus it is said:

The increase of volume of the gas (found in that process) is caused entirely by the decomposition of the methane and the olefines; the gas becoming much poorer in these, and richer in naphthaline and phenanthrene. The decomposition of the benzenoid substances in the tar may be represented in the most favorable case as follows:

$$4C_6H_6 + 2C_7H_8 + 2C_8H_{10} + 2C_9H_{12}$$
$$2(C_6H_4)_2 + 3C_{10}H_8 + C_{14}H_{10} + 2CH_4 + C_2H_2 + 9H_2$$

leaving the extensive separation of free carbon out of consideration. In 100 pounds of tar, only 2 5 pounds benzenoid substances are contained, which, if decomposed as above, would account for an increase of 0.66 per cent. of the volume of the gas. The increase would rise to 1 per cent. if the phenols were decomposed in the same manner. Naphthaline is hardly changed; the heavy oils are also very persistent against heat, and at most split off a little hydrogen and methane. The pitch and soot contained in the tar have no action whatever. Hence the Dinsmore process effects nothing else than a hot distillation of the coal—viz., increased production of gas, diminished illuminating power, obstructions by tar in the rising main and by naphthaline in the gas pipes.

Having thus disposed of the Dinsmore and other schemes for making gas from tar, Professor Lunge proceeds to give, at great length, an account of the numerous methods for the combustion of tar and other liquid fuel in boiler and retort furnaces. His general conclusion appears to be that the practical heating value of tar is about 1.2 times that of good gas coke, weight for weight. Next other uses of raw tar are dealt with—such as the preservation of building materials and the manufacture of roofing felt and lampblack. Altogether this chapter is the one likely to be the most interesting to readers of the *Journal*, until the portion of the work which treats of ammonia is reached.

In the next chapter, on "The First Distillation of Coal Tar," after a few pages on the storage and transport of tar, the reader is taken into the domain of the tar distiller; and from this point to the end of the portion of the work which deals with tar, the matter is for the most part only indirectly interesting to the gas works manager. We do not propose to follow Professor Lunge's account of the distillation of tar, etc., in detail, especially as we should have little to add to what we said in our notice of the second edition of the work.

After the chapter on the first distillation of the tar, follow chapters on "Pitch," "Anthracene Oil," "Creosote Oil," "Carbolic Acid and Naphthaline," "Light Oil and Crude Naphtha," and "Rectification by Steam" and "Final Products." These chapters are throughout very good; and the work is bound to be in the hands of every tar distiller and buyer of crude tar products. The revision of this part of the book appears to have been satisfactorily carried out, We can cordially recommend this portion of the new edition to all interested in matters of which it treats.

We then come to the final part of the work—viz., that on "Ammonia"—and as gas liquor is now so generally worked up on gas works, we must refer next week in greater detail to what Professor Lunge has to say on this branch of his subject.

The Oechelhaeuser Blast Furnace Gas Engine.

Among the early experiments made with blast furnace gas were those carried out at the Hoerde works with engines designed by Oechelhaeuser & Junkers, and built by the Berlin-Anhaltische Maschinenbau Aktien Gesellschaft, of Dessau, Germany. At a meeting held in Cologne, A. Wagener of the Deutsche Kraftgas-Gesellschaft delivered an elaborate address relating to the general subject of gas engines utilizing blast furnace gas and to the Oechelhaeuser motor in particular. Since it is one of the most conspicuous of the modern large unit engines, the following abstract is presented. The accompanying engravings, Figs. 1 to 5, inclusive, show its principal features. Each cylinder is equipped with two pistons, 1 and 2, Fig. 2, and a ring of ports, 3, Figs. 2 and 4, for the exhaust. Since the latter must be opened before the inlet valve it is more advantageously so placed that it is regulated by the working piston, which is in advance. By the rear piston two series of ring ports are operated, these being 4, for the secondary exhaust aided by admission of compressed air and the ring ports, 5, for the explosive mixture. These ports are connected with jackets surrounding the cylinder. Into the rear jacket 7 the compressor 8, driven by the rear cross head, forces explosive mixture at a pressure of 1.3 to 1 4 atmospheres. The compressed air for sweeping out the products of combustion is in the case of the Hoerde plant taken from the blast furnace main. Since the air ports remain open longer than the mixture inlet ports some arrangement had to be devised to prevent the mixture in the working cylinder from being unduly diluted by an additional flow of air or being partially forced out of the exhaust ports by it. This arrangement consists of a reservoir, 9, Fig. 2, with a positively driven valve 10, which is opened during a part of the time when the air ports are covered by the piston and allows air to enter the reservoir 9 and the jacket 6 connected with it. Shortly before the opening of the air ports this valve 10, is closed, so that the quantity of air flowing into the working cylinder for the purpose of clearing out the products of combustion is limited for each revolution in accordance with the air pressure and the volume of the reservoir and of the pipe connections between the valve and the air ports. It is worthy of note in connection with this engine that the explosion mixture pipe line 11 is very long, and that the valves for gas, 13, and for air, 14, are distant from the air compressor. One peculiarity of the engine is the use of a valve operated by the governor which permits a part of the mixture from the pressure line to flow back into the mixture supply line.

The first of these earlier engines was put into service on May 12,

1898, in the new central station of the Hoerde Company. Some hitches occurred which are worthy of discussion. Owing to drawbacks caused by the valve of the compressor the engine could not be driven to its normal speed of 135 revolutions per minute. At 120 revolutions the blows upon the cross head became so severe that they threatened the parts of the engine. Still at this speed it reached its normal power at times and was used to supply current for power and lighting purposes. But even after the fault had been remedied trial showed that it was impossible to drive the engine at normal speed, because after a short time, even under normal power, the working cylinders began to get so hot that premature igniting was feared. In fact, this did occur occasionally on the right side of the engine, which was loaded a little more. The fault was traced to the fact that the exhaust valves did not open early enough, so that a part of the products of combustion flowed back into the air jacket as soon as the air ports were opened. This fault appeared even at a speed of 120 revolutions, although it was not serious enough to cause trouble. In diagram, Fig. 6, the upper line shows the happenings in the exhaust of the products of combustion, while the lower line indicates those during the inlet of the air for clearing the cylinder. The ports for the mixture, for air and for exhaust, the latter correspondingly reduced, are indicated as to position and size in the diagram. For instance, when the piston occupies the position *b* the areas of the ports uncovered by the piston are porportional to the areas of the unhatched parts lying to the right of a vertical line drawn through *b*.

In or er to avoid the troubles due to the inadequate size of the exhaust ports the latter were considerably enlarged by chipping toward the center of the cylinder. The cards, Figs. 7 and 8, show the result, representing the inlet flow of the air, the first before and the second after the enlargement of the ports. Since then the engine has run without trouble at 130 to 135 revolutions, and even when exceeding the nominal power the cylinders are cool enough to allow them to be touched.

A further fault of this first type lay in the governing. For special reasons it had been decided not to attempt governing by changes in the proportion of gas and air in the explosive mixture, but to effect it by changing the volume of the mixture admitted. This was carried out by arranging for a valve located between the pressure and the suction lines of the mixture compressor. When opened more or less

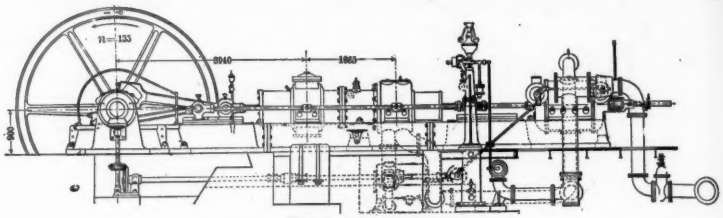


Fig. 1.—Elevation.

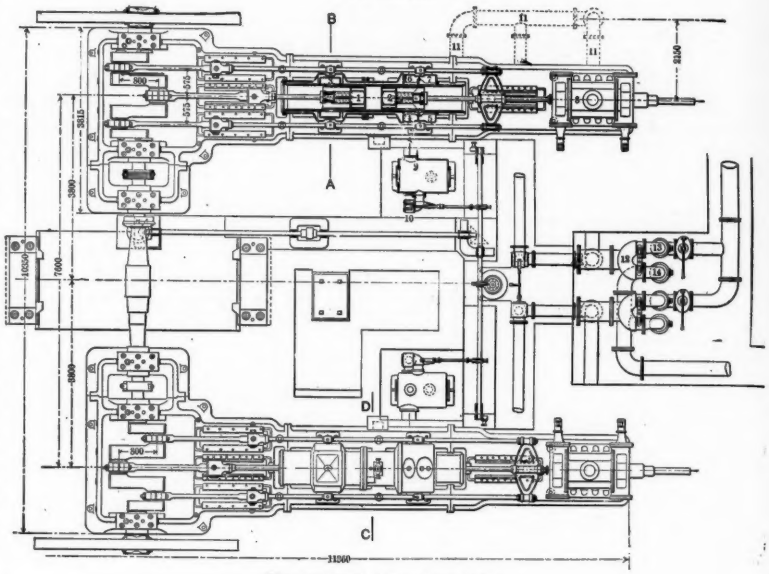


Fig. 2.—Plan of 600-Horse Power Motor.

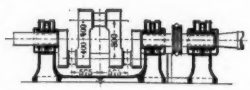


Fig. 3.—Section Through Main Bearing.

Fig. 4.—Section *A B* Fig. 2.

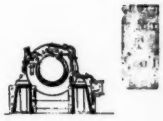


Fig. 5.—Section *C D* Fig. 2.

The Oechelhaeuser Gas Engine for Blast Furnace Gas.—Older 600-Horse Power Motor.

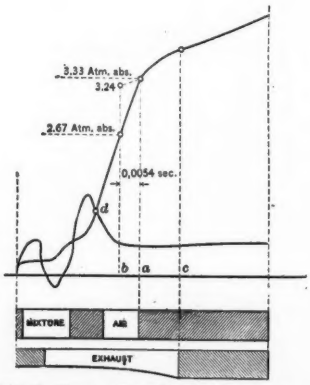


Fig. 6.—Diagram.—Upper Line, Exhaust; Lower Line, Air Admission.

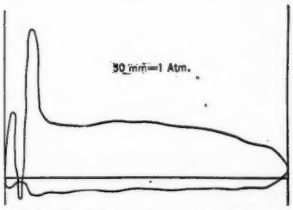


Fig. 7.—Indicator Card of Air Admission.

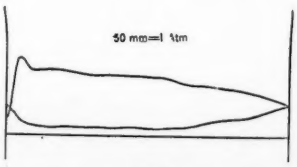


Fig. 8.
Improved Indicator Card.

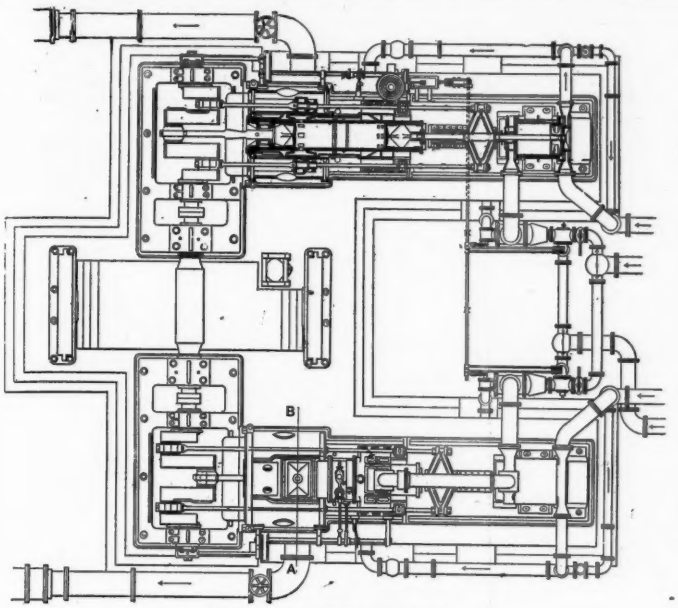


Fig. 9.—Plan of 1,000-Horse Power Motor.

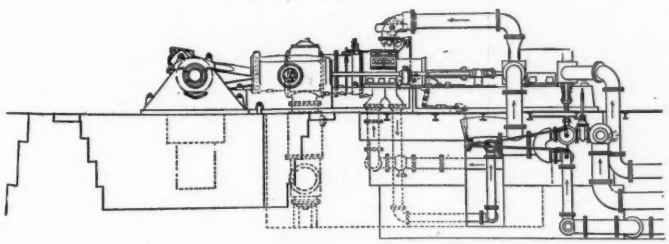


Fig. 10.—Elevation.

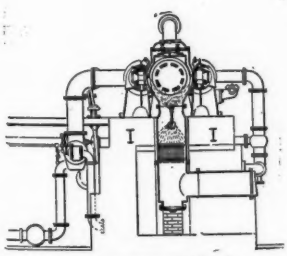


Fig. 11.—Section *A B* Fig. 9.

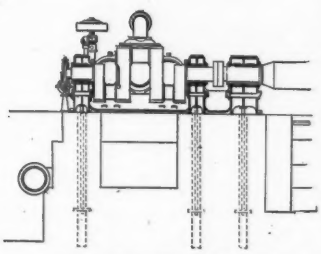


Fig. 12.—Section Through Main Bearing.

New 1,000-Horse Power Oechelhaeuser Gas Engine for Blast Furnace Gas.

by the governor, changes were created in the presure in the mixture jacket, and thus changes in the quantity of mixture flowing into the cylinder were effected. This method of governing has not proved adequate for large fluctuations in the load.

Investigation showed that disturbances in the governing were due very largely to the great length of the mixture pressure pipe. At the first Hoerde engine it was 11.35 m. long, while at the new 1,000-horse power engine the length for each cylinder is only 4 m.

Observations with the first Hoerde engine showed, too, that it is better to return to the system of governing by changing the mixture itself. Herr Wagener says that for days he has experimented with helping the governing by hand by opening and closing the gas supply cock. The slightest change is noticeable in the engine, but the effect appears 3 and 4 revolutions too late.

Since building the earlier 600-horse power Oechelhaeuser engines a larger and more modern type has been adopted, which is shown in the engravings, Figs. 9 to 12, inclusive. The working cylinder has undergone considerable modification. The compressor no longer serves exclusively for the explosive mixture, but is so arranged that one side of the piston is for this service, while the other is for the compressed air to displace the products of combustion. The governing is done chiefly by the gas and air valves placed close to the compressor and operated by the governor. Each cylinder of the engine is designed for an effective normal work of 500-horse power and is ample in size, so that the engine may be overloaded steadily by 10 per cent., and for brief periods by 20 per cent. In spite of this fact the cylinders are only 675 mm. in diameter. This is attained by the two-cycle system and by the use of two pistons in the cylinder.

The greatest dangers to a gas engine are excessive pressures and temperatures. The maximum pressures are not high in the type, because the number of revolutions may be carried pretty high owing to the balancing of the weights. As for the temperatures, there are special considerations. The cylinders and pistons are in danger not in the moment when the highest temperature is reached, but the greatest transmission of heat occurs during the exhaust, when the violent flow of the heat products of combustion causes an impact of hot particles of gas. In the case of the Oechelhaeuser engine, the small cylinders permit of effective water jacketing. During every revolution the cooling compressed air flows through the cylinder, and in the exhaust the hot gases do not come in contact with sensitive parts.

What complications the engine possesses are removed from the interior, subject to high temperatures. In the case of driving a blowing engine the blowing tube takes the place of the compressor behind the cross head, which is coupled direct to the piston rod of the blowing engine. The compressor itself is placed below the floor level and is driven from the free end of the main shaft.

At the time of the delivery of the address twenty-five 500-horse power cylinders were under construction, among them 4 for direct driven blowing tubes, and 16 arranged in 8 engines of 1,000-horse power.

An engine is also under construction for 1,000-horse power, with a maximum of 1,200 horse power in 1 cylinder.

It is designed for a speed of 100 revolutions and has a cylinder 1 m. in diameter.

This, however, does not appear to be the limit of size, since it will be possible, if desired, to build single cylinder units of 1,500 or 2,000-horse power.

For driving large dynamos, to which the Deutsche Kraft Gesellschaft is devoting particular attention, the double cylinder system is preferred, because uniformity of speed may be easily attained. Generally, sufficient weight is put into the dynamo, so that maximum fluctuations in speed of 1 in 350 are easily kept.

A New Recording Air Pyrometer.

[From a paper prepared for the American Society of Mechanical Engineers, by MR. WILLIAM H. BRISTOL.]

The instrument herein described has been designed to meet the demand for a pyrometer to measure temperatures of high ranges, and to give continuous records of changes of such temperatures on a moving chart; also to produce an instrument which would be self compensating for barometric and thermometric changes of the atmosphere without introducing delicate mechanism which would tend to inaccuracy and to preclude its use for commercial purposes.

The diagram (Fig. 1) shows the arrangement of the parts of the pyrometer, which consist simply of a porcelain bulb connected by a capillary tube to a recording pressure gauge. The stem of the porcelain bulb is made of sufficient length to pass through the furnace wall. The capillary connecting tube is made of seamless copper. The recording pressure gauge employed is constructed on the same plan as those previously designed by the author, in that each pressure tube or spring is constructed on the Bourdon principle, and consists of a tube of closely flattened cross section formed into a helix of two complete turns.

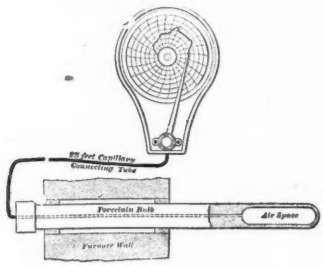


Fig. 1

Two of these pressure tubes or springs are employed in the recorder —one of these, the indicating tube or spring, being connected to the air bulb by the capillary tube, and adapted to be turned axially by the variations of pressure due to changes of the temperature to be measured; the other, a compensating spring, is mechanically attached to the free end of the indicating tube or spring. The compensating spring is adapted to be turned axially by variations of atmospheric pressure and temperature in a direction opposite to the motion of the first or indicating spring under the same influences. The compensating and pressure tubes are made of equal strength, hence external or internal pressure will produce the same angular movement in each.

The air bulb, capillary connecting tube and indicating spring are almost exhausted of air, so that when the air bulb is cold it is subjected on the exterior to nearly atmospheric pressure; but when the bulb is exposed to high temperatures the remaining inclosed air is expanded so as to practically balance the external pressure and the bulb is relieved of strains which would, in its weakened condition, tend to injure it.

The indicating and compensating springs of the recorder are shown in Fig. 2 on an enlarged scale. *C* is the bracket to which one end of the indicating spring *B* is secured; *D* represents a portion of the capillary connecting tube where it enters the stationary end of the indicating spring. The compensating spring *A* is helically formed in the same direction as the indicating spring, but of a larger diameter, so that it may be placed outside of and concentric with the indicating spring, as shown, and is mechanically attached at *E*, there being no opening or connection between the interiors of the two springs. At the free end of the compensating spring a bracket *F* is soldered, making a rigid connection to a shaft through the center of the springs. At the front end of the shaft the recording arm *G* is rigidly secured.

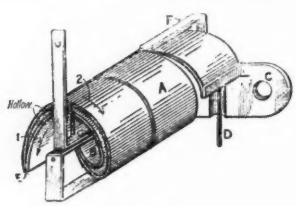


Fig. 2.

To illustrate the operation of the compensating spring, assume that the air has been partially exhausted from it, and that the barometer rises, under such a condition the indicating spring would turn to the left (Fig. 2) if the compensating spring was not present; that is, in direction of arrow 1; but the compensating spring *A* being present, and tending to turn to the right, as indicated by arrow 2, through the same angle, the effect of changes in atmospheric pressure is neutralized, and the position of the recording arm is unaffected by the rise of atmospheric pressure. For the same reasons there would be no movement of the recording arm when there is a fall in atmospheric pressure.

If the air is not entirely exhausted from the compensating spring, it will also compensate for thermometric changes in the same manner, the indicating spring tending to turn in the direction of arrow 1 when the temperature falls, and in the direction of arrow 2 when it rises; while the compensating tube will be turned in opposite directions equal amounts under the same influences. By leaving the proper amount of air in the compensating spring the compensation may be made perfect for any change of atmospheric temperature, provided the air bulb is at a given temperature. The error for small variations from the average temperature to be measured will be so small that it may be neglected. As the tubes are turned in opposite directions by barometric and thermometric changes, it is evident that there will be no movement of the recording arm unless due to changes of pressure communicated to the indicating spring through the capillary tube from the air bulb exposed to the temperature to be measured. The helically formed pressure springs are particularly well adapted for use in this instrument on account of the small internal space, which, together with that of the capillary connecting tube, forms a small volume in comparison with that of the air bulb.

Thus far, special attention has been given to working out the mechanical features of the instrument, and to determine experimentally on the most practical form of the porcelain air bulb, and how these bulbs may be applied to continuously record high temperatures. As the volume of air space outside of that exposed to the temperature to be measured is very small, and as there are no corrections or computations necessary for barometric or thermometric changes, it will be a simple matter to calibrate the instrument according to the theory of the air thermometer, which is a recognized standard for measuring temperatures. The instrument here exhibited has been calibrated by comparison with a standard from 32° up to 600° F., and by the melting points of aluminum and copper for the scale up to 2,000° F. This instrument is the joint invention of E. H. Bristol and the author.

Gas Power Electric Plant at Clausthal, Prussia.

The concluding number in *Engineering*, of the series of articles contributed thereto by Mr. Philip Dawson, on "Some Existing Gas Driven Power Plants," deals with an installation of a producer gas system, erected by the Messrs. Körting Brothers, at Clausthal, Prussia, a clear illustration of which is shown herewith. The plant in question was laid down in 1897, to supply both light and power, but chiefly light, to the town of Clausthal and its neighbor, Zellerfeld. The populations of these towns are respectively 9,000 and 4,500, and in the two towns together there are 3,500 incandescent lamps of 16-candle power, 155 lamps of 25-candle power, and 20 arc lamps, while the amount of power supplied to motors is about 50-brake horse power.

The generating station is designed to accommodate three gas producers and three gas engines, but at present there are only two installed. The engines are of the usual Körting type. They are horizontal, single cylinder, single acting engines, with one flywheel, running at 140 revolutions per minute and developing 70-brake horse power each. By means of a special appliance, with which the engines are fitted, a variation in the speed of 15 per cent. can be obtained. The governors used are of the vertical centrifugal ball type, and do not permit a variation in the speed of more than 3 per cent. when 50 per cent. of the load is suddenly thrown on or off. Each engine is directly connected to a continuous current shunt wound generator, the armature of which is mounted upon the shaft of the engine next to the flywheel. The generator gives an output of 46 kilowatts at 240 to 345 volts when running at 140 revolutions per minute. To produce a more uniform load upon the engines a storage battery has been installed. This battery contains 132 Tudor cells and has a capacity of 334 ampere hours. It is arranged in parallel on the 3-wire system of distribution. Fig. 3

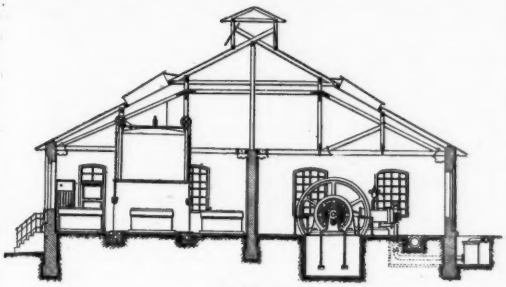


Fig. 1.

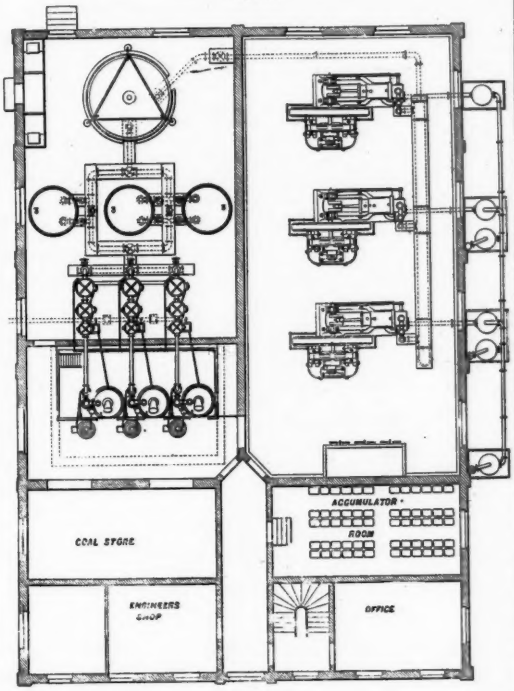


Fig. 2.

shows a plan of the plant as it will be when completed, and Fig. 1 is a cross section of the station showing the gasholder, and one of the gas engines. The latter take their supply of gas from a large main pipe which runs along the back of the engines in a trough in the floor. This pipe is connected by a smaller pipe to the gasholder. The exhaust from the gas engines is carried by underground piping to exhaust silencers situated outside the engine room.

The water used by the gas producers, and for cooling the cylinders of the gas engine, is taken from a stream, and after use most of it is returned to the stream. The quantity of water used is approximately 50 liters per brake horse power hour. The water is pumped into a reservoir situated under the roof of the engine room, by means of a pump driven by an electric motor, the water flowing from the tank through the jackets of the engines. A hand pump can be used instead of the electric motor, in case of a breakdown.

The continuous current generators are run as motors by the accumulators to start the gas engine.

MR. J. F. SEAMON has resigned the position of General Manager of the United Light Company, of Uniontown, Pa., in order to accept a similar position in connection with the gas plants at Waverly, N. Y., and Athens and Sayre, Pa. He assumed his new duties the 1st inst.

An Electric Lighting Plant for Residence Service.

Engineering Record reports that an interesting electric plant for lighting a country residence was seen recently in East Port Chester, N. Y., where seven scattered buildings, comprising the summer home of Mr. Joseph Milbank, are supplied with illumination from an independent central plant. The equipment includes an installation in duplicate of 20-horse power gasoline engines and generators, together with a storage battery, and current is distributed in underground conduit, about 3,500 feet in total length, with some conductors designed to transmit the higher tension current of a public supply, which may be received, if desired or necessary, and other conductors to carry current for charging automobile and electric launch storage batteries. Power is also used in the residence in an electric elevator.

The grounds run from a public highway on one side to Long Island Sound on the other, the facade of the house looking toward the water being the front one. The actual distances to the side limits of the property are not great, so that it was thus practically impossible to render the power building inconspicuous. It is an attractive structure, therefore, finished in a white cement stucco, with a red, low-hanging, gable roof, red and white being the general colors of all the buildings.

In plan it measures 20 x 25½ feet, while the roof ridge is about 21 feet above ground level. Inside it is sheathed with pine including the ceiling, which is 12 feet above the floor; the floor is of pine laid on 3 inches of concrete spread on the unexcavated earth.

The engines are Nash gasoline engines, of the vertical inclosed two-cylinder type, developing 20-brake horse power at a speed of 275 revolutions per minute. They are directly connected to 12½ kilowatt Crocker-Wheeler generators by means of a special coupling made by the National Meter Company, and embodying a friction clutch actuated by centrifugal weights, to set the generator free when the speed jumps beyond the normal; it is thus designed that the generator shall maintain a constant speed, even though the engine may be subject to those slight fluctuations in speed inherent in a gas engine. A 2 per cent. regulation from no load to full load was guaranteed. Gasoline is stored in two horizontal cylindrical tanks, placed underground 30 feet from the building, the distance demanded by insurance authorities, each tank of 520 gallons capacity. They are filled through pipes projecting just above the grass. The Nash double cylinder engine, it will be remembered, employs the 4-stroke cycle, receiving a charge at every two revolutions, thus giving two impulses on the crank shaft for every two revolutions.

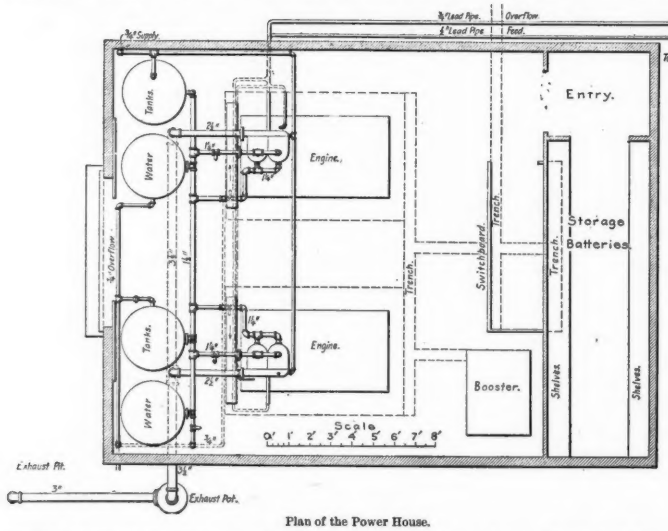
A plan of the power house is shown in the accompanying drawing. The exhaust from the engines is carried underground in a 3½-inch pipe to an exhaust pot, 16 inches in diameter and 2 feet high, for muffling, and then passes to a much larger space, indicated in the drawing, from which it subsequently escapes to the atmosphere. This space, or exhaust pit, is about 6 feet in diameter and 4½ feet deep, formed with stone masonry laid dry and capped with a stone flag covered with turf. The noise of the exhaust is thereby effectually overcome, it is stated, and the gas, which issues from a tile pipe extending from an opening in the stone cap to about 2 feet above the ground, is said to be practically without smoke or odor. Provision is made, it should be added, for injecting water into the exhaust pipe occasionally to assist in allaying smell. The cooling water is circulated on the ordinary closed system, and comprises four tanks as shown, two tanks for each engine, interconnected, with a total capacity for the four of 1,700 gallons.

The generators furnish current at 116 volts for 110 volts at the lamps. The generator leads are lead covered and run to the switchboard in wooden trenches imbedded in the concrete. The switchboard, which faces the entrance, is of marbleized slate, 1½ inches thick, and consists of three sections, one for the generator connections, another for the feeder switches and the third for the storage battery and booster. The instruments include two Weston ammeters with switches for indicating the current in the generator leads, the storage battery circuit, the elevator circuit, and that flowing from the bus bars, and two voltmeters with the usual point switches. The storage battery, which is installed to take night loads, is placed in a separate room, where the inevitable acid fumes may be dispelled without getting into the rest of the building. It was furnished by the Electric Storage Battery Company, of Philadelphia, and consists of 69 elements with a 15-ampere capacity for 7 hours at 120 volts, or 60 amperes maximum discharge for one hour. It is arranged on shelves on both sides of the storage battery room, the glass jars resting in separate sand trays. The battery is charged usually during the late afternoon and evening from either machine using a 20-ampere, 50-volt, motor driven booster in series with it for this purpose.

An underload and an overload switch, a circuit breaker and a 12-point end cell switch are provided.

A very prominent instrument of the board is a special 4 pole, double throw switch devised to stop the machinery and throw in the battery for the night load without going near the power house. In the upper portion, the outside poles complete the generator circuit through the main busses, while the inner ones complete the igniter circuit. In the lower position, the outside poles give connection with the battery. To perform the operation desired, a button is pressed in the house and a circuit is made which energizes a magnet and releases a plunger, working like that of a circuit breaker. The plunger is forced against the switch, and the switch is thrown downward into its lower position; the generators are cut out, the igniter circuit is opened and the storage battery is connected across the main bus bars. The momentary flicker of lights indicates to the distant operator that the change has taken place.

The wiring is in wrought iron pipe, laid underground in earth trenches, 2 feet 4 inches deep. The conduit was covered with two coats of tar paint and inclosed at pull boxes, which are of the standard, cast iron type, having a single branch outlet, with three thicknesses of tar paper. The feeders are lead incased, guaranteed for 500 volts working pressure, except one line, as mentioned, for which a guarantee of 3,500 volts was required. The sizes of conduit range from 1 inch for telephone to 3 inches in diameter for the light circuits. An interesting fact is that the elevator feeder is carried to the residence entirely independent of the lighting feeds, and the machine, which is an Otis elevator, is said to cause no appreciable fluctuation in the lights. This circuit has a double throw switch, so that it may be connected directly on the storage battery when desired. The greater part of the lighting is also controlled from the residence, to which two pairs of No. 000 conductors are carried from the power house, the auxiliary switchboard at the basement wall being inclosed like an ordinary distributing box.



Plan of the Power House.

Street Lighting by Electric Lamps—with Special Reference to the Systems in Use at Croydon, England.

[By Mr. F. H. Minshall, in *Electrical World.*]

It is now becoming more and more realized that in our present state of civilization well lighted streets are a necessity, and that it is not sufficient merely to indicate the direction of the road by placing lamps as far apart as the public will suffer. In the streets of a town people now require to be able to see more or less distinctly in any part of the road between the lamps. With this demand for more light, the electric lamp has passed from the position of a pretty, but capricious rival, to that of a serious competitor to be considered on equal terms with gas.

The first consideration in a system of public lighting is, at any rate when undertaken by a municipal authority, to give the public the impression of well lighted streets at as small a cost as possible. To obtain this impression, the light must be made as uniform as possible, and sharp contrasts of light and shade avoided. It is in this one respect that the arc lamp is at a disadvantage, in that it essentially consists of what is practically an intensely luminous point, and that is the condition most favorable to the production of deep, well defined shadows. If, of course, the adjacent lamps are sufficiently near, the shadows cast by one lamp cannot be very dark, but there is still the objection that the light is too intense to be viewed with comfort or safety. It is only in large open spaces, where high posts can be used, that an unshaded arc is permissible in the streets of a town.

We are obliged, therefore, to screen the arc by means of globes and diffuse the light at the expense of from 10 to 60 per cent. of the total illumination, according to the type of globe used.

Clear glass globes will absorb about 10 per cent. of the light and opal globes of ordinary thickness about 60 per cent., and this proportion of the light is absolutely wasted. The screening power of a globe is most vividly in evidence when the globe has a hole in it, through which a pencil of rays can uninterruptedly pass out. It is now becoming the practice to use opaline globes, however, which can be obtained of any degree of opacity, from almost clear glass to the thickest opal, it being recognized that to screen off more light than is absolutely necessary to comfort is a foolish waste.

Where inclosed arcs are used, it is unnecessary to use anything but clear globes, as it is found that the slight deposit formed on the inner globe is sufficient to prevent an unpleasant glare, and the gain in efficiency is very marked. But, of course, in this case, for the first few hours after fresh trimming and cleaning, until the deposit begins to form, the arc itself can be plainly seen.

Of a number of systems of lighting, the best is that which gives the greatest amount of light, most evenly distributed for the least total cost, including running expenses and interest on capital.

A comparison on this basis of the various systems in use would be very interesting, but data of the actual amount of illumination are difficult to obtain.

It may be taken as a general rule that the watts actually consumed per lamp in the lamp lie between the values 350 and 750, the average being about the mean of these two values, *i. e.*, 550 watts; and the problem is to decide in what type of lamp this power may be used to the greatest advantage. Although, light for light, it is cheaper to run arc lamps than gas, in changing over to a new system of lighting so much more is expected of the new light that this advantage is generally overbalanced by the cost of the extra light supplied.

The following table gives approximately the energy required in a few types of arc lamps in common use, as measured on the Croydon, England, plant:

No.	Type.	Current.	Volts	App. watts.	Actual watts.	Power factor.
1.	Rectified current, open arc	11.8	47	550	520	0.95
2.	Inclosed alternating	4.7	200	940	650	0.69
3.	Low wattage chokerless type	3.0	200	600	420	0.74
4.	Series alternating inclosed arc.	10.0	70	700	530	0.76
5.	Inclosed alternating (a)	—	—	—	—	—
6.	" " (b)	6.7	115	770	510	0 66
7.	" " (c)	4.4	206	906	540	0.60
8.	Alternating, open arc series	21.0	37	778	550	0.71

Lighting is required in the streets for about 3,710 hours in the year, if the lamps are on from dusk to daylight. This figure is obtained from the curve in the accompanying illustration which shows the hours of switching on and switching off the Croydon street lamps during the past year. The unsymmetrical appearance of the curve is due to the dark, cloudy mornings common in January, February and March, and the foggy evenings in November and December.

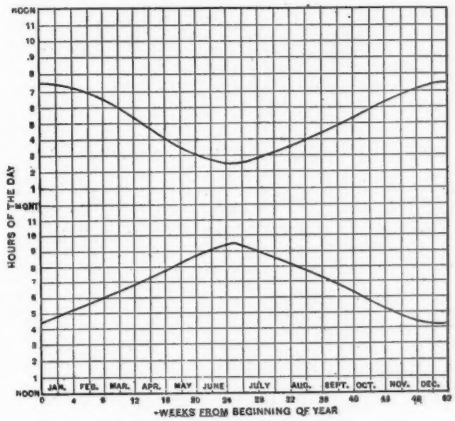
Hence the cost of energy at the generating station will be per year, for a 450 watt lamp, $50.40; for a 550-watt lamp, $61.20; for a 650-watt

lamp, $72, taking the cost per unit at the station as 0.0313 cent. This low cost per unit may be taken owing to the fact that there is no plant specially put down for arc lighting, the private lighting plant being installed of sufficient capacity to deal with both demands, and the public lighting also helps to improve the load factor.

Allowing for losses in transformers and mains in the case of alternating parallel lamps, the distribution efficiency will be about 90 per cent., and, in the case of rectified series lamps, 85 per cent., so that the actual amount annual cost of energy per lamp is, for 450 watts per lamp, $55.70; for 550 watts per lamp, $72; for 650 watts per lamp, $80.20. To this must be added interest on capital and depreciation, say 5 per cent. interest and 5 per cent. depreciation on $168 per lamp = $16.80 per lamp.

It is found that the annual consumption of carbon per lamp per year in Croydon is, for an all night lamp, as follows: 550-watt open arc rectified current lamp (233-foot 20 mm. cored, 237-foot 13 mm. solid), costing $8.46; 650-watt alternating lamp, inclosed (*a*) (67 foot solid, 31 foot cored), costing $2.26; 650-watt alternating current arc, inclosed (*b*) (109 foot cored), $4.24.

There is also the extra annual cost of the special rectifying ap-



Lighting Curves for One Year, Croydon.

paratus for the rectified current lamps, over that of the ordinary transformers required for the other lamps, which amounts to about $3.36 per lamp.

Allow also for 48 cents per lamp per year for replacement of broken globes. The total running cost per year per lamp is thus as follows:

For a 550-watt rectified current open arc	$108.30
For a 450-watt alternating current inclosed arc	80.02
For a 650-watt alternating current inclosed arc (*a*)	104.50
For a 650-watt alternating current inclosed arc (*b*)	106.48

This does not allow anything for annual cost of the share of the station plant used for arc lighting.

As regards the lamps, we may use an open arc or an inclosed, and with the former, single or double carbons. As regards the system, we have to choose between alternating and direct current, and as regards the arrangement, we must decide whether running the lamps in series or in parallel, or in combinations of series and parallel, best meets the conditions of supply.

It will readily be conceded that no engineer would use an alternating current lamp where he could, with equal facility, employ one with direct current; the reasons being that the latter will give more light per watt supplied, will give a better distribution of the light and will run silently. But, even in the case of a town supplied with direct current, there are often difficulties in economically running the arc lamps.

A 10-amp. open arc requires about 45 volts on the lamp, so that on a 100-volt circuit two may be run in series with an additional resistance of 1 ohm in the circuit, which, however, wastes 100 watts, *i. e.*, 50 watts per lamp, and so reduces the efficiency. On 200 volts, four may be run in series with the same efficiency, and on 405 volts nine will run. In this case, there need be no resistance, but the drop of pressure in the cables and leads will have to be allowed for, so that about 415 volts will actually be required. With this arrangement, however, the failure of one lamp will either cause the others to go out or else to "flare," owing to the increased voltage, unless each lamp is supplied with a resistance automatically put in circuit; this resistance, however, to absorb 450 watts at 10 amperes needs to be very cumbrous.

In the case of inclosed lamps for direct current, since the required voltage is higher, only one can be run off 100 volts, three off 220 and six off 440, with a corresponding increase in the ratio of watts used per lamp to watts supplied.

Where a high voltage direct current supply is available, a large number of lamps may be run in series, up to 40 or 50, but, as it seldom happens that the voltage necessary for the number of lamps required coincides with the standard pressure of supply, either a motor transformer or a separate direct current arc lighter must be put down.

In a large series of lamps, the risk of failure of more than one or two at one time is small, so that a constant current machine is not a necessity; but as the cost of such a machine is very little more than one built for constant pressure, the former is generally used.

It is unfortunately almost always the case that, where electric lighting is introduced into a town, during the first year or two of working only a comparatively small number of public lamps are arranged for, and what there are must be made to take their supply from the machines put down for private lighting, in order to improve the load factor. Were it possible to foresee future developments it would often be found to be wiser to put down special constant current arc lighters to run the lamps in several circuits with from 30 to 40 lamps in series in each. These machines would run at a very high load factor, and would take the place of, rather than being an addition to, a portion of the private lighting plant.

One other reason why this is not more often done is the fact that many of the types of direct current arc light machines on the market have a very low efficiency, and the cost of the useful energy supplied to the lamps is, therefore, excessive. This cost, added to the heavy annual expense of a high pressure underground cable, the use of which is compulsory in an English town, renders a series system for a district at a considerable distance from a generating station quite out of the question, assuming of course, that low tension feeders are available to carry the current for the arcs in the district under consideration.

Consider now the case of a high pressure alternating current supply, in which no special generators have been provided for arc lighting. We have the following possible methods of running:

1. Motor generator transforming high tension alternating current to high tension direct current running series circuits (*a*) from central station (*b*) from sub-stations.

2. Rectifiers transforming high tension alternating current to high tension unidirectional pulsating current, running series circuits.

3. Alternating arcs, open or inclosed, run in single parallel (*a*) off low tension mains, (*b*) off separate low tension mains from sub-stations.

4. Alternating arcs run in series off low tension distributers.

5. Alternating arcs run in series off special transformers in sub-stations at high voltage.

Method (1) would certainly be less economical in running than putting down a separate engine and arc light machine, owing to the double loss in the motor generator. In (1) *b*, although a rotating machine might run for a time unattended in a sub-station, the risk of failure would be great. The heavy capital expenditure, however, of this system alone is sufficient to prevent its adoption.

Method (2) is one which is very largely adopted in England, and, in spite of the bad reputation attached to rectifiers, in capable hands they are practically as reliable as the main generating plant. The one fault of the rectifier is the probability of the motor running out of phase should anything cause a sudden change in the speed of the alternators, such as a short circuit current on the main cable, or an alternator being switched in or out badly. Should the motor go out of phase it may be synchronized again in about a minute, but, during that time, the alternating current is passing through the lamps, causing them to "pump."

The lamps themselves are very efficient and regulate well, but, owing to the somewhat low efficiency of the direct current transformer attached to the rectifier, the gross watts taken per lamp amount to about 650 for a 12 amp. lamp. The distribution of the light is practically as good as with a direct current lamp.

Method (3) is also adopted in many cases, the arc being generally of the inclosed type. The voltage required on the lamp is about 70 in the latter case, as against 35 in the case of an open arc. The voltage

of the supply must be either transformed down to this value or reduced by means of a choking coil. Both means are in most cases adopted, and there is some difficulty in finding room for the compensator (as the special transforming device is called) the choker and the switch, in the bottom of the post.

There is, however, a type of lamp now rapidly coming into favor in England which includes the transformer and choker within the lamp itself. As the transformer is also made to act as the feed regulator, the total weight of the lamp, though high, is not excessive. The arrangement gives a large margin of power for working the feed mechanism, and requires nothing but a simple switch between it and the mains. This is the Lewis lamp. The lamp is, for an alternating lamp, efficient and has also a fairly high power factor, which is of great importance in connection with the loss in mains. A recent development of this lamp omits the choking coil altogether, and the lamp consists merely of a special moving coil transformer which gives the lamp the required voltage, and also acts as the feed regulator. The power factor of this lamp is between 70–80, since we have practically the case of a fully loaded transformer.

Before considering further different types of lamps, it will be well to pay some attention to the different ways of feeding them. The distance between adjacent posts must necessarily be determined to a great extent by the positions of side streets and the amount of traffic. A light is required at corners of roads, and more light is required where there is more traffic. The average distance apart of the lamps, however, is seldom below 40 yards or above 80 yards. In Croydon, for instance, a standard of 60 yards is adhered to where possible, with lamps taking about 550 watts in the case of rectified current and about 650 watts in the case of alternate current. With lamps placed at this distance apart it is possible to read easily a newspaper at any point between 2 lamps,

Much is made of the saving in copper effected by using a series system, and, where there is no low tension network existing, it is true that it is the only system worth considering from an economical point of view. But where a low tension system exists, even when separate arc cables are required, single parallel lighting is in cost of copper on an equal footing with series lighting, assuming that feeding points are available on the route every 1,400 yards or less.

For mechanical reasons, a series conductor of less than .025 square inch section, *i. e.*, 7-16 cable, would not be advisable, and a cable of this section is more economical than one of .06 square inch section, *i. e.*, 19-16 cable, under the conditions which obtain at Croydon, as the following figures show.

Assuming the lamps arranged as at Croyden, *i. e.*, 60 yards apart and on two separate circuits, so that the lamps on the same cable are 120 yards apart. If lamps in single parallel taking 4.7 amperes each are used on a cable of .025 square inch section, only five can be fed from one point if the voltage drop is not to exceed 16 volts in 208, *i. e.*, 4 per cent. above and 4 per cent. below the standard. This drop is allowable, but the lamps will not run well with a larger variation. This gives 1,150 yards between feeding points. If lamps taking only 3 amperes are used, the number may be increased to 6, and the drop is then 14.5 volts on the same sized cable. This gives 1,400 yards between feeding points allowable.

In this latter case, the loss in watts due to the resistance of the cable is 185. Suppose a cable of .06 square inch section were used, the drop with six 3-ampere lamps 120 yards apart will be only 6 volts, and the watts lost only 77. The difference of these two amounts of wasted energy is 600 kw-hours per annum on the assumption that 1 circuit is switched off at midnight. This means, at $0.020 per kw-hour for the extra energy required, $12 per annum, which would be saved by putting in the larger scale.

The difference in cost of these 2 cables for 1,400 yards is $588, if concentrics are used, so that the annual cost due to interest and depreciation will be $58.80 more for the larger scale as against the $12 saved in energy. If a .06 square inch triple concentric cable is used, the extra annual cost for cable will be $22.80, and the saving in energy will not be so much as before. This assumes only 1 trench excavated for both cables.

With arc mains laid in this way, lamps may be run with equal facility in single parallel off 200 volts, on the 3-wire system off 400 volts or 5 in series off 400 volts if of the inclosed type, and 11 in series off 400 volts if they are open arcs. This is method (4).

Series and parallel systems are much more on an equality as regards possible extinction of the lamps than is generally supposed. Taking first an "earth" on one of the lamps, a series system originally completely insulated will be unaffected, whereas on a parallel system, with 1 conductor earthed as on a 3-wire system, it will have the effect of a short circuit, if on the live pole of the lamp, and will cause the circuit to be shut down. It is true that there will probably be only 6 or 7 lamps on the parallel circuit, and possibly 30 or 40 in a series on 1 cable. A short circuit on the cable will, of course, in either case cause the extinction of the lamps on that cable.

A lamp which "goes to frame" without making an "earth" will, in the case of a series lamp, simply be out, and, in the case of a parallel lamp, will blow its fuse, and so cut itself out.

There is, of course, need for higher insulation on a series circuit of many lamps. So far it has been assumed that the arc lighting cables are entirely separate from the private lighting distributers, but, in many cases, the lamps are connected to the same cables as the private lights. This necessitates a man visiting every post to switch on and off, thus throwing away the advantage of being able to control a whole district from one point. Where separate cables are used, the risk of total darkness due to a cable breakdown is halved, but, of course, the capital expenditure is heavy. If the cables for arc lighting are laid at the same time as the distributers, one excavation does for both, and, as in the case of small cables, the cost of excavation and making good exceeds the value of the cable, this is a very important consideration.

The following figures show that it is not always even economical (putting aside the greater freedom from failure) to connect the lamps to the distributers for private lighting.

One man will be able to switch off, say, 40 lamps on a circuit 4,800 yards long in 1¼ hours, including his time in reaching the circuit and returning.

	Per Annum.
Man's time on round, 1¼ hours, 24 cents per day per circuit.	$78.00
Extra cost of distributer for carrying extra current, say, 24 cents per yard, 4,800 yards	$1,152
Annual cost of same for interest and depreciation	115.20
Extra units (kw. hours) required, 40 lamps for one-half hour per day = 3,285.	
Annual cost at $0.020 per unit	65.70
Total	$258 90
Annual cost of interest and depreciation on 4,800 yards of cable .025 square inch section	$201.50
Annual cost of share of pilot wire and automatic switches	6.00
Total	$207.50
Annual saving in favor of separate cables	$51.30

It is very desirable also to split up the lighting of a street into 2 circuits in order to reduce the risk of total darkness, and it is also better to put 2 lamps alternately on opposite sides of the road. This, again, adds greatly to the initial outlay, but if the cables be put all together in 1 trench and leads taken across the road at intervals, the great part of the expense is saved, as the following calculation shows.

Assume, as before, lamps 120 yards apart on 1 cable, so that 1 crossing will be required every 120 yards.

Cost of crossing, 10 yards of cable and excavation	$7.80
If across a tramway with double track, allow	18.60
Cost of separate excavation and making good, 120 yards of gravel	43.20
Ditto, 120 yards of asphalt	50.40

That is, the minimum saving is $24.60 per 120 yards of route and the maximum saving is $40.20 for the same length.

It is the standard practice in Croydon to make alternate lamps half night lamps, *i. e.*, the lamps on 1 circuit are switched off at midnight, but, from the point of view of the station engineer, this is not to be encouraged. Where separate arc mains are referred to, they, of course, only extend back to the sub-stations, except in the case of mains for rectified lamps, so that an attendant must visit each sub-station in order to switch on and off the lamps. Where, however, pilot wires are available, the lamps may be switched on and off by means of magnetic switches, worked from the central station. In Croydon, the lamps in the outlying parts of the district are switched off by this means.

The last method (5) has now to be considered. This is a series system containing a number of open alternating current arcs, and we must allow 37-40 volts per lamp, putting in a special transformer, either at the generating station or at a sub-station. The latter saves in cost of cable, but necessitates an attendant visiting the sub-station. As, however, an attendant must always go the round to report the lamps, this is of little consequence. Lamps of this type may be obtained for all

powers, from 8 amperes and 400 watts upwards. In some cases—*e. g.*, at Hammersmith, they are run from constant potential transformers, and each lamp supplied with a compensating resistance which is automatically put in circuit if the lamp should fail.

A choking coil is placed in series with the lamps and is used as a regulator in switching on the lamps. An interval af about 15 minutes elapses before the lamps settle down to a steady state.

The compensating resistance is, however, not a necessity; if each lamp is supplied with a short circuiting cut-out, the failure of one or two in a circuit of 20 to 30 will only cause the current to rise to a small extent, and it is most exceptional for more than 2 lamps in 30 to fail simultaneously. Rather more choking is required in this system in order to prevent this possible rise becoming too high. A number of lamps are running on this system at Earl's Court. A direct current transformer is considered necessary by some engineers, but the extra expense and lower efficiency seem to more than counterbalance any advantages.

Series inclosed alternating lamps are used to a considerable extent abroad, but up to the present have not found favor in England. A lamp has now been perfected which probably will have a large field. It is an alternating lamp arranged for running in series and has no cut-out and no dash pot. It has a specially designed choking coil in parallel with the arc, which, under normal conditions, take practically no energy, and only a small current, about 1 ampere; when, however, the arc is broken, the choker takes the whole of the current at the same voltage as before. The adjustment can be made so perfectly that the extinction of 50 per cent. of the lamps in a series will not visibly affect the rest.

One more system of lighting remains to be discussed, that of the incandescent lamps. Unfortunately, where gas lighting is in existence electric incandescent lamps cannot compete on equal terms with incandescent gas. In several towns, Portsmouth and Hammersmith, for instance, incandescent lamps are fixed on the same posts as the arcs, and are automatically switched on when the arcs are switched off. The light is, it is true, sufficient after midnight, but the system is somewhat complicated, and complication is to be avoided wherever possible. The practice of switching off alternate lamps at midnight seems to be the sounder, from an engineering point of view, if the light is to be reduced at all. In entirely new districts, however, where no gas lamps exist, there should be a large field for electric incandescent lighting. There are on the market several types of lamps adapted to street use which give a very good effect. Two 10-candle power lamps on each post, placed at intervals of 50 yards, give sufficient light for an average side road, and it is, of course, for these roads, where arc lamps would be an extravagance, that incandescent lamps would be used.

They may either be connected just as a house service to a distributer, or, preferably, have a separate main laid in the same trench as the distributer and brought back to the nearest sub-station, or to the end of the steeet, and a switch put in one of the lamp posts. This system is being adopted in some new districts in Croydon.

In conclusion, attention is drawn to the importance of foresight in laying out a system of public lighting. The cost of excavation is, as a rule, so heavy, amounting in most cases to more than the value of a single cable of the length of the trench, that if all the cables required for both private and public lighting can be laid together in one trench, a very large initial outlay will be saved, besides obviating the inconvenience to the public of opening the road more than once.

Considering how really frail and complicated a thing even the simplest of arc lamps is, and how small a defect will cause irregularity or extinction, there is cause for congratulation that arc lighting has earned public approval to the present extent, in that there is hardly a town of any importance that has not at least its principal streets lighted by its means.

Although we have not yet by any means reached finality, we have advanced far, and do not now have to supplement our electric lamps by gas kept in readiness. Where we still fall short of the ideal is in being unable to produce a lamp small enough and cheap enough to be used at very frequent intervals, so as to more nearly obtain the uniformity of illumination which we want.

THE Citizens Gas and Fuel Company has been incorporated to take over the plant and franchise of the Dunkirk (N. Y.) Gas Company. The new concern is to be capitalized in $200,000, and the parties principally concerned in its fortunes are Messrs. Street, Wykes & Co., of this city. Mr. E. C. Perry will retain his interest in the Company. It is proposed to extend the mains to the adjoining town of Pomfret.

The Influences Exerted by Power Factor.

By MR. F. H. LEONARD, JR.

Power factor is the ratio of the true watts to the apparent volt amperes in an alternating current conductor, circuit or device (Houston). In a direct current circuit the energy is calculated by multiplying the volts by the amperes, and the result is the true energy in the circuit in watts, but in alternating current circuits this does not follow, as the electromotive force wave is out of phase with the current wave in every case except when the load is purely non-inductive, as with a load consisting of incandescent lamps only. When arc lamps or induction motors are used there is always a lagging phase displacement of the current, and when synchronous motors are used there is also a phase displacement of the current, which may be either leading or lagging behind the electromotive force wave, and both conditions may occur, in the case of the generator being driven by a steam engine, twice in each revolution.

With water power, a steam turbine or other prime mover where the angular velocity can be maintained practically uniform and where speed variations affecting the generator take place gradually in a period covering several revolutions of the generator, much better results can be obtained with synchronous motors, always of course presuming that the motor is designed to, and does in practice, give the same electromotive force wave as that produced in the generator, which for reasons which have been at length discussed by many able authors should be a sine curve. Power factor is comparatively a new term to the central station manager, and, in fact, was hardly ever heard of before the introduction of the alternating current motor, though some central station superintendents had noticed that there was considerable current flowing in their primary circuits when all their transformers were running with open secondary circuit, and that this current did not take the energy from the steam engines corresponding with the volt ampere readings. To express this condition the terms "false currents or wattless currents" were used.

The transformer when very lightly loaded or when running with open secondary takes much more apparent energy from the circuit than the real energy, because of the lag or phase displacement of the current wave. This displacement, however, grows constantly less as the load is increased, until the electromotive force and current waves nearly coincide. To illustrate this graphically, the two diagrams of electromotive force and current waves in a transformer in open circuit and under full load show that the instantaneous values of the product of volts and amperes must be less than the apparent watts, and must be multiplied by the power factor to represent the true energy. As will be noted, the maximum electromotive force occurs before the current has reached its maximum point. Referring to the full load curve, it will be seen that the current and electromotive force curves have nearly reached conditions where they increase and decrease together. The nearer this condition is approached the nearer the power factor approaches unity or 100 per cent. power factor.

As an induction motor is practically the same as a transformer with one of its elements in motion, its action with regard to power factor may be traced in the same manner, as explained in connection with a transformer. The primary circuit furnishing the magnetizing current or field and also the work current by induction to the secondary, when running light generates a counter electromotive force so high that only enough current is taken in the secondary to overcome the friction of the bearings. As load is added the speed is slightly reduced, the slip resulting in lowering the counter electromotive force until enough current is allowed to flow to do the added work. A very slight reduction in speed is sufficient to reduce the counter electromotive force of the secondary of the motor varying not to exceed 5 per cent. in speed from light to full-load, and usually not over 2 per cent. over the working range of load usually met with. These motors are self starting from the alternating current lines, and with suitable starting devices take about full load current for a few seconds in coming up to speed light, or a little more than full current in bringing up to speed their normal load, a somewhat longer time being occupied in reaching full speed, depending on the inertia and friction characteristics of the work. If you will consider the counter electromotive force of the motor secondary as the equivalent of resistance of the transformer secondary the similarity of action will be more striking. The synchronous motor differs from the induction motor from the fact that it does not make its own field, which is usually excited from a separate source of direct current, and it is not usually capable of starting itself even without load, but must be brought up to synchronous speed by

means outside of itself. A small induction motor is generally supplied for the purpose, which is disconnected after the synchronous motor has been brought up to speed. The load is then applied gradually with a friction clutch coupling, friction pulley or equivalent device.

Once in step, the synchronous motor cannot vary in speed, except the generator driving it changes speed, any more than though the two were positively coupled or mechanically geared together, except by overload much beyond the capacity of the motor, which breaks it out of step as though the gear were broken, and having fallen below speed even for a fraction of a second, it cannot recover, but will stall, in the meantime absorbing excessive current unless the circuit is immediately opened.

The load must then be thrown off and the motor started again as at first. The fact that the synchronous motor has a separately excited field is an advantage under certain conditions, as pointed out in my paper before the National Electric Light Association at the New York meeting in 1895. By increasing the field excitation sufficiently in a synchronous motor the apparent paradox of a counter electromotive force higher than the line or impressed electromotive force is produced by the motor sufficient to raise the electromotive force of the line, overcoming all drop, and even altering the pressure at the generator itself, at the same time introducing leading currents having a condenser effect on the line which may be made to balance out the lagging currents produced by induction motors, arc lamps, etc. If this leading phase displacement can be made equal to the lagging phase displacement of other devices, a power factor of unity would result, as suggested by an eminent engineer, though in practice, during a period covering the whole history of this branch of the art, I have never met such a condition, nor have any of my friends in the profession, many of whom have had extensive experience with synchronous and induction motors separately and both together on the same circuit.

An over excited synchronous motor in the right place, with a load not subject to sudden variations and in charge of an attendant in communication with and controlled by the central station chief, is a convenient means of overcoming line drop and poor power factor. Over excitation should not be carried too far, as it will result in pumping or flickering the lights. I have a vivid recollection of a case in which a 2½-horse power self-acting synchronous motor, which I designed, pumped the whole circuit on a 300 kilowatt alternator. Under a steady load and careful adjustment of the field excitation, a large synchronous motor supplied with current from a well designed generator driven by water power or steam turbine, a power factor at full load of .94 or a fraction better may be obtained, though the same motor furnished with current from the same generator driven by a slow speed reciprocating engine, would hardly attain a power factor of .90 at full load, as the flywheel moment of the motor would make it difficult to follow the changes in angular velocity of the generator, the tendency to break out of step resulting in surges of current, as before intimated.

Generators directly connected to slow speed reciprocating engines, in my opinion, are not suited for operating synchronous motors or rotary converters unless extreme care is taken in designing the fly wheel so as to obtain the minimum change of angular velocity per revolution. A much larger percentage of speed variation taking place more gradually, is less disastrous to the attainment of high power factor.

The best load for a synchronous motor is one of uniformly steady character with no sudden changes in the work it has to do. Throwing the load off suddenly calls for instantaneous adjustment of field excitation in order to prevent sudden rise of electromotive force, which in a large motor would affect the whole line, and even change the voltage of the generator, having a disastrous effect on incandescent lamps that may happen to be in circuit. Suddenly adding a load to a synchronous motor has the reverse result and adjustment of the fields become immediately imperative to prevent heavy drop in electromotive force. A single synchronous motor subject to sudden load variations may easily defeat any attempt at good regulation on the part of the central station management. These objectionable features are minimized, though never wholly overcome, by designing both generators and motor for exceptional regulation, using a distributed armature winding with a large number of slots per pole per phase.

The old style armature with windings concentrated into a single slot per pole per phase are unsuited on account of their high armature reaction for this class of work.

[To be Concluded.]

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

We understand that the American Gas Company, of Philadelphia, has secured control of the Steubenville (O.) Gas and Electric Company. Important betterments are planned for the gas works.

Advices by way of Baltimore, Md., are to the effect that Eastern capitalists have virtually secured control of the Petersburg (Va.) Gas Company.

Mr. Henry C. Kelsey, formerly largely interested in the gas supply of Newark, N. J., and ex-Chancellor of the State of New Jersey, has been appointed temporary receiver for the Bay State Gas Company, of New Jersey. In the order naming Mr. Kelsey it is further ordered that on December 24th the Company shall, in the United States Circuit Court, sitting in Trenton, show cause why the receivership should not be continued during the pendency of the proceedings which caused the naming of the receiver.

Mr. Samuel F. Butterworth, of Washington, D. C., writing to the Journal under date of the 5th inst., says:

To the Editors American Gas Light Journal: I am looking up the subject of the use of gas for the heating of a large building, preferably by the use of hot water circulation. I have written a number of the stove and boiler makers and have received only one reply. In the natural gas region such apparatus must be in use, and if you can give me any information or references whereby I can find out what has been done in that line, it will be greatly appreciated.

Perhaps Mr. Henry L. Doherty may give Mr. Butterworth some information on the subject. He certainly can, if he will.

The Town of Hempstead Gas and Electric Light Company, of Rockaway Beach, Long Island, has found it necessary to greatly enlarge and modernize its gas works, due to increased volume of business. It has accordingly awarded a contract to the United Gas Improvement Company for an installation of its standard double superheater Lowe water gas apparatus, of a daily capacity of about 400,000 cubic feet. Many other improvements are also being added to the plant, which, when completed, will be a credit to its owners.

The Allegheny Steel and Iron Company will erect a steel plant at Brackenridge, Pa. The contract for the buildings has been awarded to the American Bridge Company, and the agreement includes two producer sheds, a boiler house, a main building, an open hearth building and a crane runway. The main building will be 72 feet by 252 feet, with four lean-to's. The open hearth building will be 72 feet by 161 feet, with three lean-to's. About 500 tons of steel will be required.

Major T. Atwater Barnes is spoken of as a likely successor to the late Mr. Andrew W. De Forest in the Presidency of the New Haven (Conn.) Gas Light Company.

The proprietors of the Caledonia (N. Y.) Natural Gas Company have put the net selling rate for gas used on fuel account at 50 cents per 1,000 cubic feet, and at 70 cents for an illuminating supply.

The Central Gas Light Company, of San Francisco, Cal., has petitioned the proper authorities for a dissolution of its charter. It is merely a nominal proceeding, the Company having been consolidated with the old San Francisco Gas Light Company something like 5 years ago.

It is said that Mr. H. H. Pearson, representing a Philadelphia syndicate, has made an offer for the purchase of the franchise and property of the New Orleans (La.) Gas Light Company, which offer seems to meet with favor by those in control of it. As we understand it the syndicate agress to take over the plant and operate the same, under a guarantee to the present owners of a 6 per cent. per annum return, the syndicate to have the right at any time to become the absolute owner of the property by paying $125 per share for the capital stock.

In the reorganization of the Saginaw (Mich.) Gas Company, the Directors elected were: George B. Morley, John M. Morley, George L. Burrows, Thomas Merrill and Charles F. Neuendorf.

At a special meeting of the Directors of the New Haven (Conn.) Gas Light Company, to take suitable action respecting the memory of the Company's late President, Mr. Andrew W. DeForest, the following memorial was ordered placed on the minutes:

"The Directors of the New Haven Gas Light Company, in grateful

recognition of the long and valuable service, as a member of their Board, of Andrew W. DeForest, who departed this life on the 29th ult.—in the 21st year of his directorship and the 7th year of his presidency of the Company—desire to place upon the records of the Company this memorial of the ability, fidelity and usefulness by which this official service has been distinguished.

"Especially is it fitting that such commemoration be had of his wise and prudent administration of the affairs of the Company during the 7 years of his presidency. His integrity of character, his sound judgment and fine intelligence, his gentleness of disposition and urbanity of manner, combined with his thorough acquaintance with the affairs of the Company and his earnest desire always to keep his interests in harmony with the interests of the community which it serves, have brought to him uniformly the respect and confidence of that community, and particularly of all who have had any business relations with the Company and have contributed in a very large degree to whatever success has attended the growth of the Company during this period.

"To his associates of this Board his death has come as a personal sorrow, and they extend to his widow and family the sincere assurance of their warmest sympathy."

Dr. R. C. Layton, in order to assume the duties of Secretary of State, under Governor-elect Hunn, of Delaware, has resigned from the Board of Directors of the Bay State Gas Company, of Delaware.

Mr. G. W. T. Richmond, of Richmond & Co., Limited, London, E.C., a concern whose gas cookers, gas heaters, etc., are famous the world over, has been spending some weeks in America, for the purpose, as he said, of looking over and around what the gas appliance makers of America are doing in the pushing of their wares, and as to the efforts made by our gas companies on similar lines. He has covered a good many thousands of miles in his travelling and has interviewed and associated with numbers of our representative gas men. Shortly after his arrival here he presented letters of introduction to the Journal, and on taking his leave, he promised to look in on us again before sailing for home. The circumstances were such that he could not carry out the latter part of his agreement. However, he forwarded us a chatty sort of a letter in the way of an adieu, and we believe we violate no courtesy in reprinting some of its sentences. Here they are:

New York, December 7th, 1900.

To the Editors American Gas Light Journal: I had hoped to have been able to have called upon you to-day, but, through many unexpected delays, I find the evening has come and I am yet far from Pine street. * * * I have been much impressed with the extent of your wonderful resources, and I feel that, in the matter of ceaseless work and untiring energy, we have a good deal to learn from your country. The extraordinary features which natural gas presents have greatly interested me. I am also interested in seeing the way in which the gas companies here control, in some cases, the electric light companies, and, in at least one case, not only the electric but also the traction company operating street cars. Frequently natural and manufactured gas concerns are under the same management. The gas companies here seem to be more alive to the necessity of pushing the sale of gas fuel than on our side, but I do not think they have anything like as good an article as the English companies; in fact, if it were not for the import duties, I believe a very large business would be done on this side by English merchants, but a 45 per cent. tariff makes this impossible. I am afraid, however, it is scarcely likely that your President and his associates will reduce the tariff in our favor, although I had a very pleasant chat with him when in Washington, and I was also granted an interview with Sir Wilfred Laurier, of Ottawa, Can.

The following notice was issued to the residents of Rutland, Vt., on the 1st inst., by Mr. George H. Verder, President of the Peoples Light Company of that city:

The Directors of the Peoples Light Company, at a meeting held at their office, passed the following resolutions:

Whereas, The liberal reduction in the price of gas made by this Company during the past 15 months has not induced, as was reasonably expected, a corresponding increase in the consumption thereof; and

Whereas, The limited amount of gas used, and the increased price of coal and oil, will not warrant a continuance of present rates to customers,

Resolved, That the price of gas furnished by this Company shall, from and after the 1st day of December, 1900, be established at $2.25 per 1,000 cubic feet, a net advance of 28 cents.

All bills for same will be entitled to a reduction of 20 per cent. if paid on or before the 15th day of each month, at the office of the Company on Evelyn street.

At a special meeting of the proprietors of the Westerly (R. I.) Gas and Electric Light Company it was determined to extend the Company's electric lighting system to the summer resort of Watch Hill, which place is famous for its "ocean breezes."

All indications are to the effect that the residents of Andover, Mass., incline to giving the right to supply gas in that district to the Lawrence Gas Company rather than to the hastily incorporated Andover Gas Company, a concern that has every appearance of a desire to practically play the role of the dog in the manger.

The American Bridge Company is fabricating, at its Gillette-Herzog branch at Minneapolis, the structural steel for the Webster County Court House, Fort Dodge, Ia.

The plant and franchises of the Sheboygan (Wis.) National Gas Company, have been sold by the United Gas Improvement Company, to Mr. James T. Lynn and his associates. In the reorganization the following officers were elected: Directors, M. B. Daly, F. T. Hance, A. B. Eaton, J. T. Lynn and Howard Lesher; President, J. T. Lynn; Secretary and Treasurer, H. J. Lesher. The new proprietors will expend a large amount of money next spring in plant on manufacturing and distributing accounts.

The Providence (R. I.) Gas Company recently had an odd experience in its coal storage sheds. The coal in a compartment holding 1,000 tons was ignited, presumably through spontaneous combustion, the ignition seemingly having started at the base and in the center of the pile. How much damage was done we are unable to state.

It is reported that Cape May, N. J., is hereafter to be lighed as to its streets by means of Welsbach lamps instead of electric lights.

The new proprietors of the Portsmouth (N. H.) Gas, Electric Light and Power Company, have announced their determination to reduce the rate for a gas supply to $1.50 per 1,000 cubic feet, a cut of 50 cents per 1,000.

Mr. W. B. Brinton, of the Peru-La Salle Gas, Light and Power Company is authority for the statement that the gas division of the plant is to be rebuilt.

In the annual report of the Buffalo (N. Y.) Gas Company, which was made public towards the close of last month, its President, Mr. A. C. Humphreys, said, among other things:

"The net profits for the year were $288,394, and there was required for bond interest (5 per cent. on $5 805,250) $290,250, showing a deficit of $1,856. The previous year showed a suplus of $12 286. Had it not been for a long continued and expensive strike at the main works, there would this year, in spite of the reduced gas sales, have been a surplus of not less than $25,000. The strike finally resulted in a complete victory for the Company.

"The sales of gas decreased during the year 3 per cent.; the falling off the previous year was, however, over 7 per cent. Until June, 1900, the sales were, month by month, smaller than during the like months of the previous year. In June there was a slight increase, and this improvement has continued. Natural gas is selling throughout the better parts of Buffalo at 27½ cents per 1,000; it is used for fuel, and, with Welsbach burners, for light. Your Company's gas is sold for $1 per 1,000, showing the difficulty in meeting such competition. Only by following the most liberal policy towards the public have your representatives succeeded in retarding, and finally, it is to be hoped, checking the loss of business. Judging, however, by the experience in other localities, the supply of natural gas available for distribution in Buffalo must diminish year by year. Cooking stoves and other fuel appliances have been introduced among the Company's illuminating gas consumers, the net gain for the year being 2,516.

"The receipts per 1,000 feet of gas sold were ¼ of a cent more than in the previous year, and the cost of gas delivered, in spite of the strike and other exceptional items, was about ¼ of a cent less per 1,000. About $14,000 more was spent this year than in the previous year for repairs and maintenance of plant. During the year 5¼ miles of main pipe was laid, bringing the total mileage up to 367¾ miles. The balance sheet shows a surplus of quick assets over floating debt of $48,258.23. There is also in the treasury $95,000 in bonds."

On the 30th of November, Mr. John P. Harbison, President and Treasurer of the Hartford City Gas Light Company, completed the 45th year of his active connection with that well managed corporation.

The Bellingham Bay Gas Company, of Fairhaven, Wash., has removed its business headquarters to spacious and handsomely fitted rooms in the building at Holly and Bay streets.

The proprietors of the Louisville (Ky.) Gas Company, it is said, will, on the 1st of next January, reduce the rate on illuminating gas account to $1 per 1,000 cubic feet, a concession of 30 cents per 1,000.

All difficulties in respect of the proper reorganization of the Hanover (Pa.) Gas Company have been cleared away by the granting of the new charter. The gentlemen in control of its fortunes are: C. J. Lippman, F. H. Shelton, M. M. Freeman, R. L. Forrest and John H. Cromie, Jr.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO., PROPRIETORS.

MONDAY, DECEMBER 17, 1900.

The Market for Gas Securities.

The net result in the trading in city gas shares for the week was a slight decline in quoted values, but the undertone sung for strength. The developments in respect of complete amalgamation were next to nothing, yet the calculations that are being carried on point to near announcements of what the real ending is to be, in the instance of the final disposition of the Brooklyn Union Company. As far as nominal quotations go, values in Consolidated and Brooklyn Union are not notably away from those of last week, and, on the whole, the quoted prices are representative of strength. The business of both the named Companies continues to increase in marked manner. Mutual we quote at 295 to 299. It is certainly cheap at the big end of the naming; but we imagine there is not much of it for sale.

The market for out-of-town shares is dull and uneven, although business in Peoples, of Chicago, was done at advancing figures. The feature of the out-of-town division, though, was the announcement by the Indianapolis manipulators that dividends on those shares would be suspended until the Indianapolis gas consumers became greater respecters of the ownership in the commodity that the Company sells and that the consumers buy. This thing is referred to in our current editorial columns. Bay State is below 1, and Baltimore Consolidated is steady. The United Gas Improvement Company's regular dividend of 2 per cent. is payable Jan. 15. That stock looks to us a purchase at the reported offering price to-day (Friday) of 129.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 Wall Street, New York City.

December 17.

☞ All communications will receive particular attention. ☜ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$54,595,200	100	188¾	189
Central Union, Bonds, 5's.	3,000,000	1,000	108½	109½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	120	..
Metropolitan Bonds	658,000	..	108	112
Mutual	8,500,000	100	295	299
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co.. Bonds, 5's	11,000,000	1,000	103¼	105
Northern Union, Bonds, 5's.	1,250,000	1,000	104	104¼
New York and East River Bonds 1st 5's	3,500,000	1,000	105	105½
" 1st Con. 5's	1,500,000	..	115	..
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	130	133
Preferred	5,000,000	100	150	153
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	114
Yonkers	299,620	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	174	178
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	⅜	..
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	30	40
" 1st Mtg. 5's	503,000	1,000	90½	91½
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7	9
" " Bonds, 5's	5,250,000	1,000	68	71
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	194	198
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	105
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	50¼	50¾
Mortgage, 6's	3,500,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	10	17
" Con. Mtg. 5's	880,000	1,000	80	85
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,560,000	50	95	97
" Prior Lien 5's	4,737,000	1,000	99½	100
Detroit Gas Co., 5's	381,000	1,000	100	101
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co..	1,000,000	50	100	105
" 1st Mtg. 5's	1,225,000	1,000	..	..
Hartford	750,000	25	240	250
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	68	70
" Bonds, 6's	2 650,000	..	95⅞	97½
Jackson Gas Co.	250,000	50	70	75
" 1st Mtg. 5's	265,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	86
Bonds, 1st 5's	3,822,000	1,000	101½	103
Laclede, St. Louis	8,271,000	100	70	72
Preferred	2,500,000	100	95	100
Bonds	10,000,000	1,000	107	107½
Lafayette Gas Co., Ind.	1,000,000	100	40	50
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	70	75
" 1st Mtg. 6's	350,000	1,000	102½	103
" 6 per cent. scrip, due 1901	100,000	25	87	8
Montreal, Canada	2,000,000	100	182	184½
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	98¼	99
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	90¾	91
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co.	1,500,000	100	47	05
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,465,000	1,000	88	90¼
St. Joseph Gas Co.	1,000,000	100	31	34
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	9	10
Bonds	1,612 000	1,000	88½	93
Washington, D. C	2,000,000	20	273½	275¼
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	100	95	98
Bonds, 5's	3,330,500	..	107	107½
Wilmington, Del.	600,000	50	200	201

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., N. W. CORNER BROAD AND ARCH STS., PHILA., PA., Dec 12, 1900.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable January 15, 1901, to stockholders of record at the close of business, Dec. 29. Checks will be mailed.

1332-4 LEWIS LILLIE, Treasurer.

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Manager of a Small Gas Works.

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Five feet to 6 feet in diameter.

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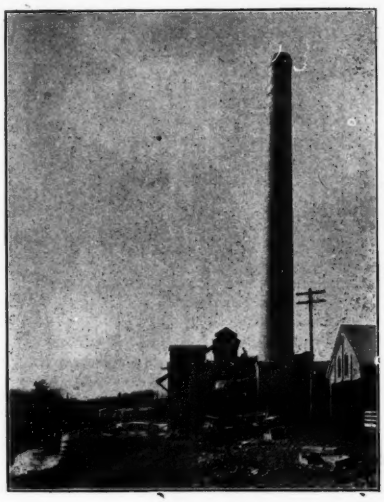

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EDWIN E. WITHERBY, Manager.

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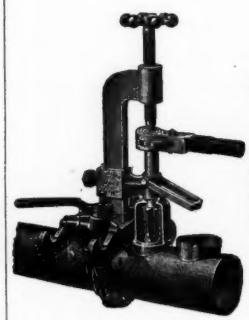

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Gas Tapping Machines.

If you have the satisfaction of knowing that the taps your men make are made in the easiest and best manner, and that they stay good, we know you are using a Mueller Machine.

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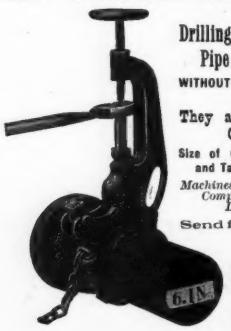
GAS TAPPING MACHINES
—FOR—
Drilling and Tapping Pipe under Pressure
WITHOUT ANY ESCAPE OF GAS.



They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

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Hazelton Water Tube Boilers.
HIGH PRESSURE.

The Pioneer Vertical Water-Tube Boiler of the World.

Over 11½ Square Feet of Heating Surface per Horse Power.

High Quality and Durability of the Tubes the Most Vital Part of a Boiler.

Fastened at One End Only, Expand and Contract Without Strain, Averting any Possibility of Leakage.

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Boilers we Built have been in Constant Use 18 Years, and are in Operation To-day with Fine Results.

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Small Floor Space, Less per Horse Power than for Any Other Boiler.

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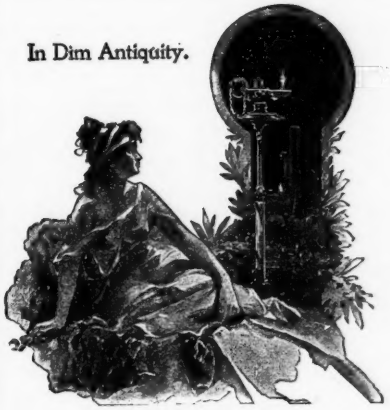
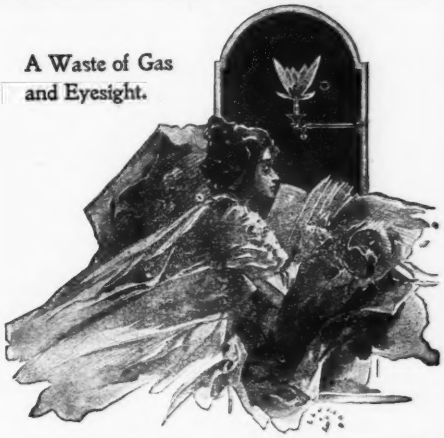


A Waste of Gas and Eyesight.



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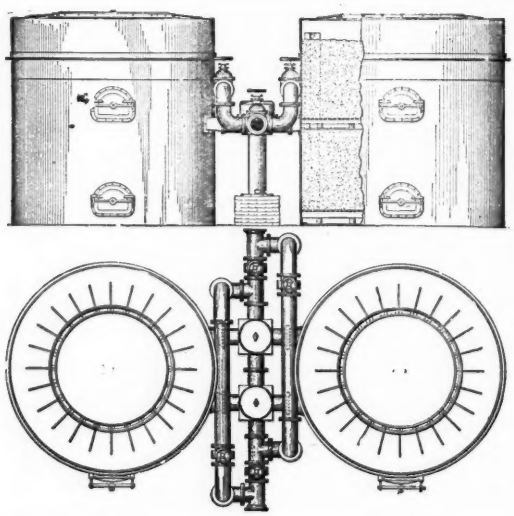

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Covered by Five U.S. Patents.

In operation, revivification of the oxide is effected by repeated reversals of the direction of the flow of the gas through the beds (in the two boxes used under this system there are eight different routes for the gas to take) whereby the purified gas is made to revive the oxide in parts of the apparatus while the foul gas is fouling it in others.

The boxes are charged or discharged from the sides as well as the top.

There are no Hydraulic Cups or heavy covers.

Either end of the apparatus is inlet or outlet at pleasure.

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The apparatus costs less than for any other system.

For Estimates Write **The Stacey Mfg. Co.,**
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American Offices: 269 FRONT STREET, EAST, TORONTO, ONT.
London Offices: 19 ABINGDON STREET, WESTMINSTER, S.W.

Telegraphic Address: "CARBURETED LONDON AND TORONTO."

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	Cubic Feet Daily.
Blackburn, England	1 250,000
Windsor Street Works, Birmingham, England	2,000,000
Saltley Works, Birmingham, England	2,000,000
Colchester, England	300,000
Birkenhead, England	2,250,000
Swindon (New Swindon Gas Company), England	120,000
Saltley Works, Birmingham, England (Second Contract)	2,000,000
Windsor Street Works, Birmingham, England (Second Contract)	2,000,000
Halifax, England	1,000,000
Toronto	250,000
Ottawa	250,000
Toronto (Second Contract, Remodeled)	2,000,000
Lindsay (Remodeled)	125,000
Belleville	250,000
Ottawa (Second Contract)	250,000
Brantford (Remodeled)	200,000
St. Catherine's (Remodeled)	250,000
Kingston, Pa.	125,000
Montreal	500,000
Peterborough, Ont.	250,000
Wilkesbarre, Pa.	750,000
St. Catherine's (Second Contract)	250,000
Buffalo, N. Y.	2,000,000
Winnipeg, Man.	500,000

	Cubic Feet Daily.
Colchester, England (Second Contract)	300,000
York, England	750,000
Rochester, England	500,000
Kingston, Ont.	300,000
Crystal Palace District, England	2,000,000
Duluth, Minn.	300,000
Caterham, England	150,000
Enschede, Holland	150,000
Leicester, England	2,000,000
Buenos Ayres (River Platte Co.)	700,000
Burnley, England	1,500,000
Kingston-on-Thames, England	1,750,000
Accrington, England	500,000
Tonbridge, England	300,000
Stretford, England	500,000
Oldbury, England	300,000
Saltley Works, Birmingham, England (Third Contract)	2,000,000
York, England (Second Contract)	750,000
Rochester, England (Second Contract)	500,000
Newport, Monmouth, England	250,000
Todmorden, England	500,000
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Gas, Electric Light, Water Works, and Electric Street Railways Built, Remodeled, Operated, Bought and Sold.

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Tarrytown, N.Y., 3 orders.
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Gainsville, Fla.
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Waterville, N. Y.
Huntington, L. I.
Lexington, Mo.
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Asheville, N. C.
Youngstown, O.
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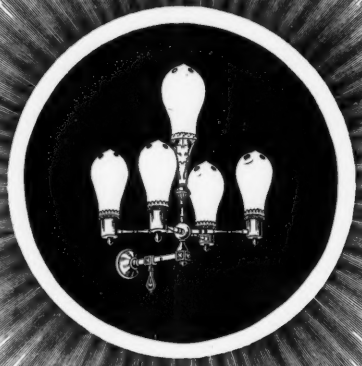

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SAVES 80 PER CENT. OF YOUR GAS BILL.

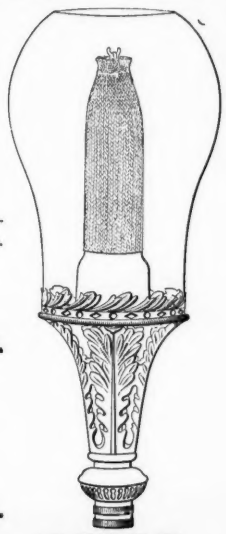
THE NEW DISCOVERY.
BURNS ONE CUBIC FOOT OF GAS PER HOUR.

No Chimneys to Break. Mantles do not Blacken. Better than Electricity, and only 1-10th the Cost. Not a mere statement, but a Guarantee.

CAN BE USED WITH { MANUFACTURED GAS. NON-CARBURETTED GAS. NATURAL GAS OR GASOLINE GAS.

35 TO 40 CANDLES PER CUBIC FOOT.

Burner No.	0	consumes	8-10	cubic foot,	30-candle power.
"	1	"	1	"	35 "
"	2	"	2	cubic feet,	70 "
"	3	"	3	"	105 "
"	4	"	4	"	140 "
"	7	"	7	"	225 "



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PURIFIER TRAYS?

Church's Patent Trays
have never been equaled for ease of repair, strength of slat and slight resistance to passage of gas. We are the only makers.

Our Bolted Trays
are the strongest and best now in the market. We make a great variety of styles, and would be glad to send you descriptive circulars and prices.

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MANUFACTURERS OF
Valves and Gates for Gas, Ammonia, Water, Etc.
Also, Gate Fire Hydrants with and without Independent Nozzle Valve. All Work Guaranteed.
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PRESSURE GAUGE.
For continuous records of
Street Gas Pressure.
Simple in construction, accurate in operation, and low in price.
Fully Guaranteed. Send for Circulars.
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Silver Medal, Paris Exposition.

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TROY, N. Y., U. S. A.
Double and Single Gate Valves, ¾" to 72",
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HOT GAS VALVES A SPECIALTY.
Send for Catalogue.

Steward Burners.

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Samples to be Had for the Asking.

Write for neat vest pocket memorandum book. Sent Free.
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IT IS OF INTEREST TO
Gas Companies
THAT AN EVEN PRESSURE IS MAINTAINED AT ALL TIMES.

THE "VULCAN" GAS CONTROLLER
will do it.
For all kinds of gas, including acetylene.
No mercury or glycerine used.
The most simple, inexpensive and effective governor on the market
Made in three sizes.
List Price, ¼-inch, $4.50; 1¼-inch, $5.50; 2-inch, $8.
Should be attached by Gas Companies to insure correct work and best results.
Every Controller guaranteed absolutely. Discount to the trade.
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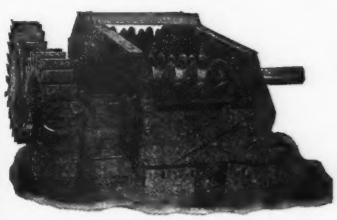
ENGINEERS, FOUNDERS, MACHINISTS,
Chicago, U. S. A.



"Link-Belt" Breaker.

LINK-BELT ELEVATING & CONVEYING MACHINERY for HANDLING COAL, COKE, OXIDE, ETC.
Tilting Coal and Coke Cars, Breaker Rolls, Shaking Screens, Power Transmitting Machinery.
Machinery designed and erected to suit existing conditions and available space
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AMERICAN GAS COMPANY

Constructors of Coal Gas Apparatus.

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P. H. & F. M. ROOTS CO.'S
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AMERICAN GAS COMPANY,

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Coal and Water Gas Plants.

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RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

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Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.

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LATEST IMPROVED GAS EXHAUSTER

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NEW GAS GOVERNOR AND STEAM VALVE.

GUARANTEED TO REGULATE WITHIN ONE-TENTH OF AN INCH, WATER PRESSURE.

The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
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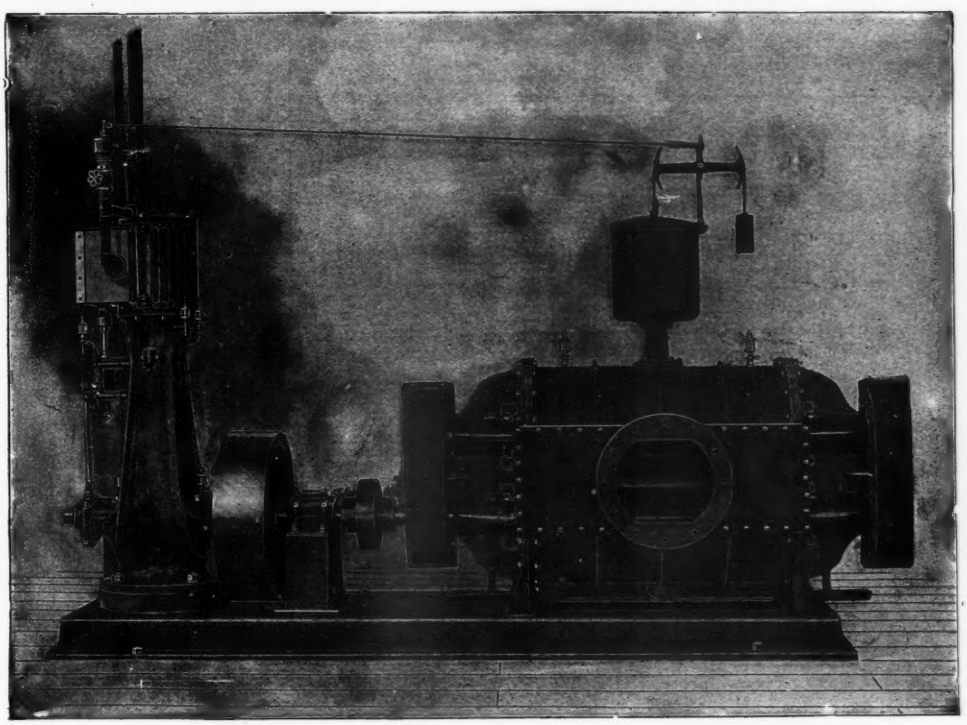

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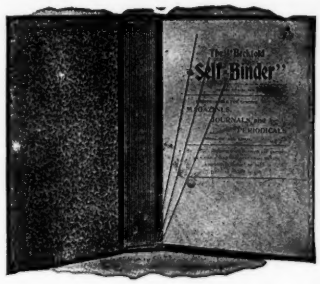

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STORAGE TANKS FOR GAS WORKS,

To Retain Fluid Material of Any Sort.

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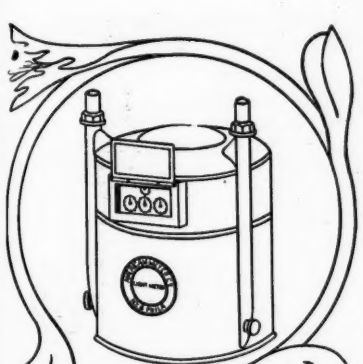
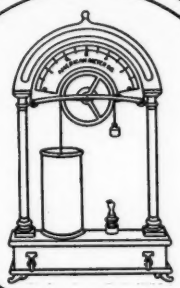
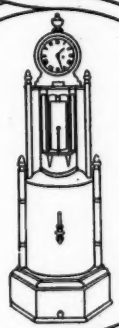
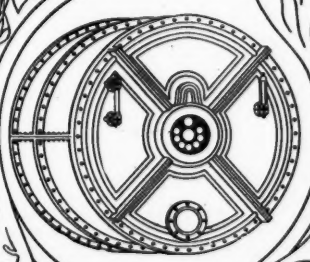
Work Done for Several of the Largest Gas Companies in America Stands as Reference.









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AMERICAN METER CO.

ESTABLISHED 1836. INCORPORATED 1863.

NEW YORK AND PHILADELPHIA,

CHICAGO, ST. LOUIS,

SAN FRANCISCO.

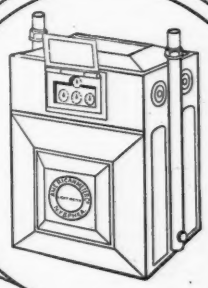
PUBLIC LIGHTING TABLE.

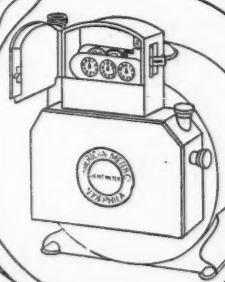
JANUARY, 1901.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light. P.M.	Table No. 2. New York City. All Night Lighting. Extinguish. A.M.
Tue.	1	3.50 AM	6.20 AM	4.30	6.30
Wed.	2	4.50	6.20	4.30	6.30
Thu.	3	No L.	No L.	4.30	6.30
Fri.	4	No L. FM	No L.	4.30	6.30
Sat.	5	No L.	No L.	4.30	6.30
Sun.	6	5.20 PM	8.00 PM	4.30	6.30
Mon.	7	5.20	9.00	4.30	6.30
Tue.	8	5.20	10.00	4.40	6.30
Wed.	9	5.20	11.00	4.40	6.30
Thu.	10	5.20	12.00	4.40	6.30
Fri.	11	5.20	12.50 AM	4.40	6.30
Sat.	12	5.20 LQ	1.50	4.40	6.30
Sun.	13	5.30	2.50	4.40	6.30
Mon.	14	5.30	3.40	4.40	6.30
Tue.	15	5.30	4.40	4.50	6.25
Wed.	16	5.30	5.40	4.50	6.25
Thu.	17	5.30	6.20	4.50	6.25
Fri.	18	5.30	6.20	4.50	6.25
Sat.	19	5.30	6.20	4.50	6.25
Sun.	20	5.40 NM	6.20	4.50	6.25
Mon.	21	5.40	6.20	4.50	6.25
Tue.	22	5.40	6.20	5.00	6.25
Wed.	23	5.40	6.20	5.00	6.25
Thu.	24	5.40	6.20	5.00	6.25
Fri.	25	10.20	6.20	5.00	6.25
Sat.	26	11.30 FQ	6.20	5.00	6.25
Sun.	27	12.40 AM	6.10	5.00	6.25
Mon.	28	1.50	6.10	5.00	6.25
Tue.	29	2.50	6.10	5.05	6.15
Wed.	30	3.40	6.10	5.05	6.15
Thu.	31	4.30	6.10	5.05	6.15

TOTAL HOURS LIGHTING DURING 1901.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	220.10	January	423.20
February	192.30	February	355.25
March	180.00	March	355.35
April	158.30	April	298.50
May	140.40	May	264.50
June	135.40	June	234.25
July	138.00	July	243.45
August	156.20	August	280.25
September	174.40	September	321.15
October	202.30	October	374.30
November	220.40	November	401.40
December	241.30	December	433.45
Total, yr.	2161.10	Total, yr.	3987.45





NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

Welsbach Street Lighting Company

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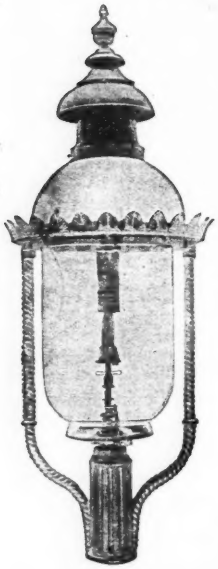

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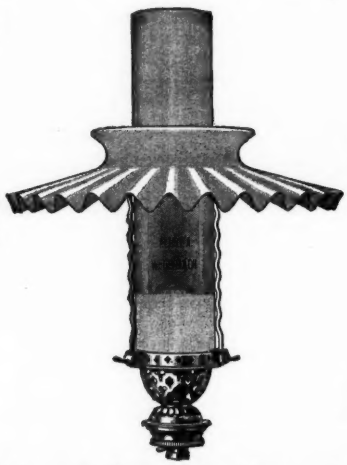

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THE STANDARD DOUBLE SUPERHEATER LOWE WATER GAS APPARATUS.

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WEST CHESTER, PA.	1	SEATTLE, WASH.	1
COHOES, N. Y.	2	TARRYTOWN, N. Y.	1
OGDEN GAS CO., CHICAGO	1	HOBOKEN, N. J.	2
CENTRAL UNION GAS CO., NEW YORK	1	PATERSON, N. J.	2
SPENCER, MASS.	1	NEWARK, N. J.	2
SAN FRANCISCO	1	JERSEY CITY, N. J.	1
BROOKLYN UNION GAS CO., BROOKLYN	1	AUSTIN, TEX.	1
RICHMOND, VA.	2	ELIZABETH, N. J.	1
CAMBRIDGE, MASS.	2	ROCKAWAY BEACH, N. Y.	1
CARBONDALE, PA.	1	NEWTON, N. J.	1
HACKENSACK, N. J.	1	Phœnixville, Pa.	1
TIFFIN, O.	1		

NUMBER OF SETS 31
TOTAL SETS INSTALLED TO JANUARY 1, 1900 327
TOTAL SETS INSTALLED TO DATE 358
TOTAL DAILY CAPACITY . . . . . 227,775,000 Cubic Feet.

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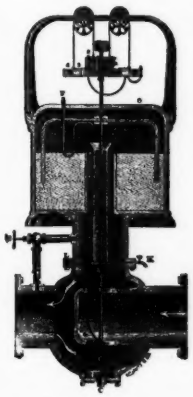

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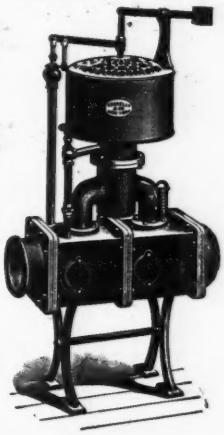

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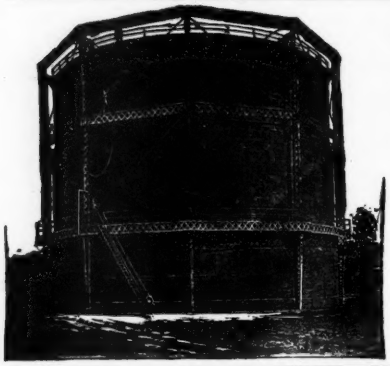

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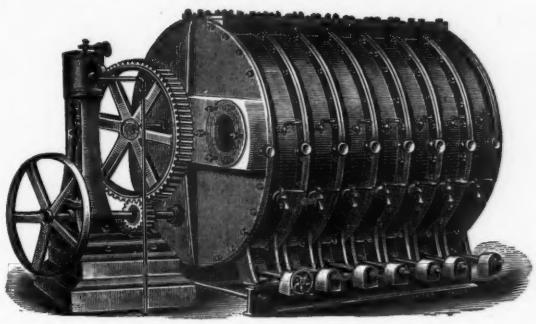

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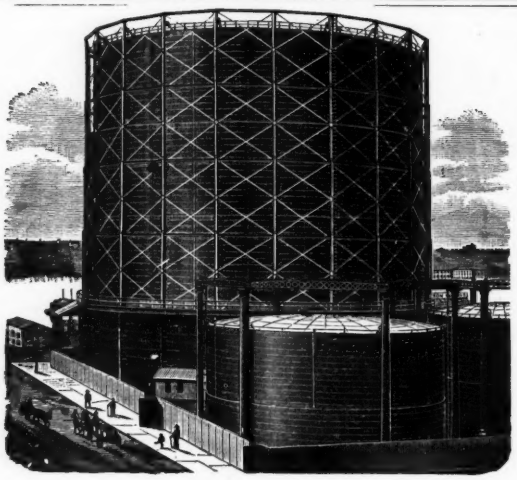

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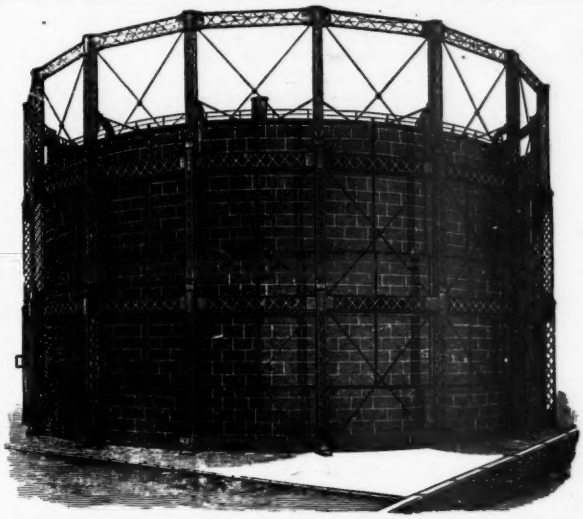

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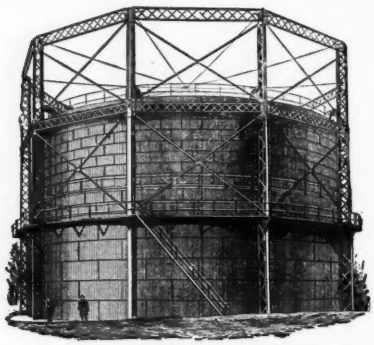

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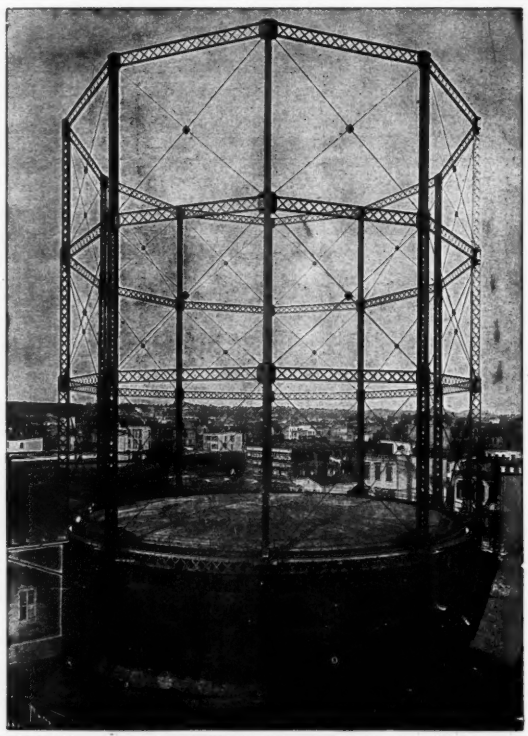

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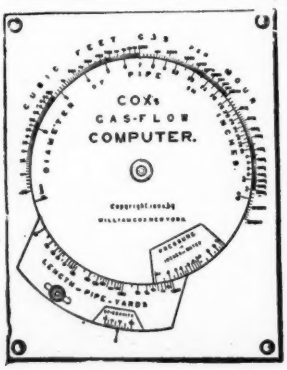

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